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ABSTRACT

This volume contains the 30 formal papers that were accepted for the European and Third World Gender and Science and Technology (GASAT) Conference. The theme of the conference was "Science and Technology, A Future for All?" The papers are presented in two parts and organized into four frames. Part one contains papers, reporting empirical research or analyses. The papers presented in part two are reports of the position of women in science and/or technology in various parts of the world or of initiatives of many kinds that have been taken to change the existing situation. Frame 1 deals with problems, constraints, methods, and questions at the primary and secondary level in school with the most important focus being girls in school. Frame 2 includes contributions from the upper secondary level to higher education levels at the college and university level. It also includes teacher-training issues and students' attitudes to technology and industry. The focus of Frame 3 is women in the workplace. Issues included are opportunities for women, conditions of working, and career development. The problems and opportunities in developing countries are discussed in this frame. Papers that are in some way relevant to other frames are included in Frame 4. These papers have been grouped separately and raise ethical, moral, philosophical and methodological issues. Some of the papers contribute to more than one frame. Each frame is concerned mainly with science and technology. Topics include physics teachers, affective factors, educational models of change, physics education, computer studies, women in construction, engineering education, study environment and sex differences, training in guidance and counseling for non-traditional careers, gender equity, social responsibility, innovative science classroom practices, and career choice by women. (A separately published "Supplement" volume, containing five additional papers, has been appended.) (KR)

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PREFACE

EUROPEAN AND THIRD WORLD GASAT CONFERENCE MAY 1990

The GASAT Conferences bring together women and men who are concerned about the alienation of girls and women from science and technology and about the interaction of gender with science and technology and who are working to remedy these problems.

International conferences have been held every two years from 1981 in the following countries, in order, The Netherlands, Norway, United Kingdom, United States and Israel.

Though this conference addresses mainly to Europe – and follows a similar European conference organized in Denmark in 1986 – it is open to participants from all parts of the world and especially invites and sponsors those from the Third World.

Participants were invited to contribute to the conference in one of the following ways:

- formal papers, workshops, symposia, poster papers and round-table discussions.

This volume contains the formal papers which were accepted for the conference and which were distributed to the participants before the conference.

The papers are presented in two parts and organized into four frames.

Part one contains papers, reporting emperical research or analyses.

The papers presented in part two are reports of the position of women in science and/or technology in various parts of the world or of initiatives of many kinds which have been taken to change the existing situation.

The GASAT-papers are divided into four frames.

Frame 1:	These papers deal with problems, constraints, methods and questions at the primary and secondary level in school. The most important focus is the girls in school.
Frame 2:	This frame includes contributions from the upper secondary level to higher educational levels at College and University. It also includes teacher-training issues and students' attitudes to technology and industry.
Frame 3:	Women in the workplace is the focus of the content in this frame. Issues included are opportunities for women, conditions of working and career development. The problems and opportunities in the developing countries will be discussed in this frame.

Frame 4: In some of the papers the discussion is on a metalevel. In some way these contributions may be relevant to other frames as well. They have been grouped separately and they raise ethical, moral, philosophical and even methodological issues.

Some of the papers contribute to more than one frame. Each frame is, of course, concerned mainly with science and technology.

The conference was organized by a local planning group and a European programme committe.

The members of the local group are

Ingrid Granstam	Project leader
Lieve Brissman	Secretary until May 1989
Inger Frostfeldt	Secretary from August 1989
Birgitta Allvin	
Christina Chaib	
Solveig Mononen	

Jan Harding joined this group as adviser for three weeks in February 1990.

The members of the programme committe are

Ilja Mottier	The Netherlands
Magda Man in't Veld	The Netherlands
Anette Kolmos	Denmark
Doris Jorde	Norway
Anne Lea	Norway
Svein Sjöberg	Norway
Patricia Murphy	England
Christina Ullenius	Sweden
Christina Chaib	Sweden
Ingrid Granstam	Sweden
Jan Harding	England

FRAME 1

These papers deal with problems, constraints, methods and questions at **the primary and secondary level in school**. The most important focus is the girls in school.

FRAME 2

This frame includes contributions from the **upper secondary level to higher educational levels** at College and University. It also includes **teacher–training** issues and student's attitudes to technology and industry.

FRAME 3

Women in the **workplace** is the focus of the content in frame 3. Issues included are opportunities for women, conditions of working and career development. The problems and opportunities in **the developing countries** will be discussed in this frame.

FRAME 4

In some of the papers the discussion is on a **metalevel**. In some way these contributions may be relevant to other frames as well. They have been grouped separately and they raise **ethical, moral, philosophical** and even **methodological issues**.

Some of the papers contribute to more than one frame.

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PHYSICS TEACHERS: DO THEY MAKE A DIFFERENCE?

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Context of the research

In the Netherlands, over 20% of the girls in secondary education visits a school for junior secondary education (in 1987: 22.9%). This makes junior secondary education the most important school-type for girls in the age-group 12-16. For boys, junior technical education is the most important school-type after primary education, followed by junior secondary education.

Most of the pupils in *senior vocational education* come from either junior secondary education or from junior vocational education. For girls the most important route to *senior technical education* is junior secondary education, since there are very few girls in junior technical education. Unfortunately, only 13-14% of the girls in junior secondary education chooses physics for final exams, a percentage that has stayed constant since 1971 while the percentage of the boys choosing physics increased (mostly during the late seventies and early eighties) from about 50% to 57%. Physics is a compulsory subject for almost half of the studies in senior vocational education (including senior technical education), so girls that did not do physics are severely restricted in their opportunities. Only four additional studies require only mathematics but not physics. The percentage of girls doing mathematics exams in junior secondary education has increased considerably from less than 30% in 1972 to 50% in 1987 and keeps increasing under the influence of information campaigns.

We can conclude that girls' option choice in physics is still much of a problem whereas girls' option choice in mathematics has become much less of a problem. In senior secondary education (12-17) the situation in physics and mathematics is much the same.

The influence of physics teachers

One of the goals of the MENT-project is to facilitate the participation of girls in senior technical education. This implies that in the physics part of MENT we are interested in what happens in the physics education of girls in secondary education, in particular junior education. We think the physics teacher plays an important role in providing the physics-related experiences that either attract or repel girls. From the theoretical model of subject-choice that Eccles (1982, 1987) developed we can derive that physics teachers influence their pupils' apprecation of and self-confidence in physics in a number of ways, such as:

- providing certain kinds of learning experiences, information and role-models;
- propagating expectations concerning the achievements, behaviours and careers of their pupils;
- giving certain kinds of feed-back to pupils on achievement and behaviour.

In the Netherlands, research about teachers and their influence on girls' appreciation and choice of their subject is scarce. Recent research among mathematics teachers in all kinds of secondary general education has shown that perceived (by pupils) behaviour of the teacher cannot be related in a systematic way to gender-differences in achievements, choice and attitudes and that on average pupils did not perceive their maths-teacher to be stereotyped (Kuyper and Meulenbeld 1988). Kuyper and Meulenbeld were mainly interested in the influence of the teacher on gender-*differences* and in a first stadium of their research in which also physics-teachers were included they found no relevant differences between mathematics- and physics teachers with respect to their influence on gender-differences. We think however that it is also very important to look at the effect of the teacher on girls' experience of physics, irrespective of boys' experience of physics. It might well be possible that physics teaching that is attractive to girls is attractive for boys too, so under the influence of other than teacher-linked variables the gender-differences might stay the same.

When pupils say they do not perceive stereotypical behaviour and opinions of their teacher, this does not mean there is no actual stereotyping going on. For instance Jungbluth (1982) showed that science and mathematics teachers in junior secondary education were most stereotyped and least aware of specific problems of girls in physics and mathematics. Also, in very detailed observations of a physics teacher helping girls in doing electronics experiments, patterns were found that could continue or enhance girls' lack of self-confidence in physics (Lubbers and Menting 1985): the teacher assumed the girls understood concepts and procedures they did not in fact understand and the girls were not able to communicate their problems to the teacher. The teacher did not recognize what the real problem was.

A preliminary study among physics teachers and their pupils in junior and senior secondary education

In the MENT-project we plan to do research among physics teachers in secondary education, to gain more insight in the *actual processes in physics-classes that either attract or repel girls.* In a preliminary investigation that was meant to further specify the research questions, variables and hypotheses for further research, 5 physics teachers in junior and senior secondary education were interviewed. Their pupils in one of their classes (grades 2-3) and one additional class were asked to fill in a questionaire. To get more specific information, each of the teachers was asked to indicate of 6 randomly selected pupils (3 girls, 3 boys) what he thought of their ability in physics, personal characteristics, behaviour in the class-room and their future plans. The information the teachers gave was compared with information from the pupils themselves. The investigation took place in april 1989.

The questionnaire for the pupils was partly adapted from the one that Kuyper and Meulenbeld used in their research about the influence of mathematics teachers. This part of the questionnaire consists of a number of assertions about:

- the attitude of the pupil toward physics;
- perceived gender-stereotyping of the teacher;
- perceived behaviour of the teacher;

We added items about the perceived opinion of the teacher about ability and behaviour of the pupil. The items could be responded to on a 5-point scale ranging from 1 (disagree strongly) to 5 (agree strongly). The rest of our questionnaire for pupils concerned itself with report-marks, personal characteristics (such as inventiveness, diligence, etc..) and plans for future education and career. In this paper we report some findings from the questionnaire for pupils and some comparisons between teachers' and pupils' data on stereotyping physics as a 'boys' subject' and future plans. We discuss the consequences of these findings for further research.

Results from the questionnaire for pupils

Scale-construction and remarks on the scales

137 pupils completed the questionnaire. 134 questionnaires could be used. With the help of factor-analysis (separately on the above-mentioned 4 different parts of the questionnaire) a number of scales consisting of 3 or more items could be formed that had reasonable to good reliability (Cronbach's α):

NAME	DESCRIPTION	# ITEMS	α
I	*Attitude of pupils towards the school-subject physics*		
PUPABLE	Pupil's self-concept of abilities in physics	5	.91
PUPLIKE	Liking of physics and physics-lessons	6	.92
PUPSTEO	Pupil's stereotyping physics as a male domain	3	.79
PUPCONF	Pupil's self-confidence in physics and -lessons	5	.71
II	*Perception of the teacher's evaluation*		
PERCABLE	Pupil's perception of what the teacher thinks about her/his abilities in physics	8	.91
III	*Perception of the teacher's behaviour*		
PERCQUAL	Pupil's perception of the didactical qualities of their teacher	7	.84
PERCPREF	Pupil's perception of their teacher's "preferential" treatment of girls in the physics lessons	4	.82
IV	*Perception of teacher's sex-stereotypical beliefs*		
PERCSTIM	Perception of the teacher stereotyping physics as more important for boys than for girls	4	.80
PERCSTAB	Perception of the the teacher stereotyping boys' and girls' abilities	4	.80

There were also 4 scales consisting of 2 items that might be interesting to extend in a next version of the questionnaire since they relate to variables that are often considered important in gender-research in science. The 2-item 'scales' can be related to the societal value of physics ($\alpha = .90$), the perception of the pupils of what the teacher thinks about their diligence ($\alpha = .68$), the perception of the pupil of how much the teacher emphasizes the personal relevance of physics ($\alpha = .67$) and the perception of the pupil of denigrating and nasty remarks that the teacher makes ($\alpha = .64$). Since the items on the 'societal value' scale are difficult to interpret despite their high correlation and the other 2-item scales have too low reliability for the numbers of pupils in this research, we shall not analyze them further. The reasons it could be interesting to improve the 2-item scales are:

- *Societal value of physics:* It is often hypothesized that especially girls would be more interested in physics if the societal value of physics is emphasized in a non-stereotypical way (de Leeuw 1986, Mottier 1987).
- *Diligence in physics:* a well-known stereotype is that of the diligent but not really brilliant girl and the bright but not very diligent boy that could cause teachers to give a gender-specific interpretation to the same achievements. That is: a girl who achieves reasonably has reached her highest level

whereas a boy with the same results could do better if only he worked harder, as one physics teacher told me (AA) some years ago.

- *Relevance of physics:* Especially girls experience physics-education as something that has nothing to do with their own lives because the teacher never mentions examples from daily life, professions that use physics etc. From the Second International Science Study (SISS) we know that the Dutch teachers mention the relevance of science least of all teachers in six developed countries (Tamir 1988).
- *Denigrating remarks:* A lot of sex-stereotyping may be going on in sarcastic remarks, for instance if these remarks are often directed at boys but almost never at girls and especially when they have a sexist content (Alting & Udo 1987). The message behind such remarks is that the teacher feels involved with the physics achievement of boys while at the same time excluding girls from the "physics community".

Data from pupils compared with data from teachers

We shall now give some results on the scales and discuss them in relation to more qualitative data from the teachers themselves about a subgroup of the pupils. Of course these results may not be generalized. After all this is a pilot-study. If we find some striking results this only means we have to be alert to the relevant variables in follow-up research with a more carefully sampled group of pupils and teachers and instruments that are better geared to the research questions we are interested in.

Table 1 **Scale means for girls and boys**

SCALE	GIRLS n=60-66	BOYS n=65-69	d	mean σ	sign.
1 PUPABLE	2.4	3.1	0.7	1.0	****
2 PUPLIKE	2.7	3.3	0.6	1.0	**
3 PUPSTEO	1.5	1.9	0.5	0.9	**
4 PUPCONF	3.2	3.6	0.5	0.8	**
5 PERCABLE	2.3	3.0	0.7	0.9	****
6 PERCQUAL	2.8	3.1	0.4	0.9	*
7 PERCPREF	1.9	2.3	0.5	0.9	**
8 PERCSTIM	1.7	2.1	0.5	0.8	**
9 PERCSTAB	2.2	2.2	0.1	0.9	n.s.

Note:
$d = (\text{difference of means})/\text{mean } \sigma$
scale 9: $d \neq 0$ because of rounding
* 5%, ** 1%, *** .1%, **** .01% significance level

From table 1 we see significant and large gender-differences on all the scales except on the perception of teacher's stereotyping of ability. On average girls score negatively on all the scales except the self-confidence scale and boys score neutrally to positively on all the scales except the stereotyping scales. The correlation between scale 1 (pupil's self-concept of ability) and scale 5 (perception of teacher's opinion about ability) is strong for both sexes: r=.74 (girls) and r=.87 (boys). According to the data from the teachers about how they perceive the ability of a randomly selected subgroup (n=25) of the pupils (11 girls, 14 boys) there seems to be agreement between the pupils and the teacher about ability. That means that most of the pupils have a fairly accurate perception of what their teacher thinks about their ability.

For the boys, the correlations with *intended choice* are strongest for PERCABLE (r=.53), PUPLIKE (r=.52) and PUPABLE (r=.49). For the girls we see the same variables but in a different and more pronounced order: PUPLIKE (r=.66), PUPABLE (r=.51) and PERCABLE (r=.42).

Stereotyping physics as a male domain

From table 1 (scale 3) we see that on average the pupils do not stereotype physics as more important for boys and boys as more able in physics. The girls are even less stereotyped than the boys. On the other hand there are weak but significant correlations between a girl's stereotyping physics as a male domain and her self-confidence and self-concept of ability (r=-.48 and -.37 respectively) but this is not the case for boys (r=-.13 and -.24 respectively). That is to say: the less a girl disagrees with the notion that physics is a boys' subject, the less self-confidence she has in physics and the less positive she thinks of her abilities. Also for girls there is a substantial correlation between stereotyping physics as a male domain and most recent marks (r=-.56) whereas for boys r=-.13. (Note: most recent marks as reported by the pupils -in april- are in general a weighted mean of marks on the evaluation reports during the schoolyear.)

Girls and boys do not perceive their teachers to stereotype the importance of and the achievements in physics. Of the 5 teachers in this study no particular teacher is perceived by his pupils (girls as well as boys) to be significantly more or less stereotyped than the others in opinions and behaviour.

The data from the teachers themselves do not confirm this however: One of the teachers (grade 3 of senior general education) thinks that physics is less important for girls than for boys and from the rest of his data it is clear that he did not make a mistake there: For instance, when asked if Jenny's "8 marks" form a good representation of her abilities in physics, he thinks that this result is too optimistic in comparison with Jenny's "real" abilities, because *"The good result has more to do with coincidence than with ability because she had good luck in making some tests"*. When asked the same question in relation to John's "6 marks" he thinks John's "real" abilities are higher, because *"He does not choose physics although he finds it interesting, but he spends his energy on the subjects he has chosen for his exams."* Later on the teacher contradicts himself by saying that John shows "exaggerated diligence" and John himself confirms that he always studies hard in physics and always does his homewerk.

The teacher would agree if Jenny chose physics because *"She has the capacities - more or less -"*; if John chose physics he would also agree, but in this case he leaves out the 'more or less'. If Paula (7 marks) chose physics he would agree, because *"She has the capacities - but not in abundance -"*. He thinks her marks are in agreement with her "real" ability in physics. John, Paula and Jenny themselves think their marks are in agreement with their "real" abilities in physics.

The teacher expects a traditional choice of future education for boys and girls (except when the pupil told him his plans, as is the case with John): Nordin for instance, who achieves well in physics, wants to go to senior commercial education and become a bookkeeper but his teacher thinks he will go to senior technical education. Both Jenny and Paula want to continue with senior general education but their teacher thinks they will visit senior domestic education instead.

It can be concluded that this particular teacher shows a consistent and stereotypical view of the importance of physics, the future education of girls and boys and the abilities of girls and boys. This might cause him to be rather reluctant to the physics choice of a girl but supportive of the physics choice of a boy, as is illustrated by Jenny's remark: (My teacher would agree with my physics choice because) *"I asked him myself if I could manage next year."* and Orhan's remark: (My teacher would agree etc because) *"He said I could manage it (physics) well."*

The other four teachers do not show such overt sex-stereotyping in their remarks on pupils. If there is disagreement between a girl's and her teacher's evaluation of her "real" abilities in relation to her most recent marks, the teacher tends to think the girl's abilities are higher. *"The girl could have achieved better if only she had worked harder"*, according to one teacher, speaking about all 3 girls he was questioned about respectively.

Asking pupils about stereotyping opinions and practices of their teachers may be questionable, as the above results show. Some possible causes for contradictory results could be:

- Pupils are solidary with their teachers against an outside researcher;
- Pupils are afraid of the consequences if they mention negative things about their teachers, despite of guaranteed anonimity, especially if they have to fill in the questionnaire during a physics lesson and the physics teacher has to gather and send them back to the researcher. One of the teachers had checked the data the pupils gave about their achievements as was clear from the notes he had made on some questionnaires.
- Pupils cannot compare their teacher with other physics teachers;
- In the case of sensitive matters the pupils tend to respond to an item according to how they think the situation should be instead of how the situation actually is.

Comparison between choosers, non-choosers and hesitators

The pilot-study took place in the middle of april, when pupils in the third grade of junior and senior secondary education should be fairly sure about subject choice for final exams. Pupils in the second grade of junior general education already can drop some subjects but the final subject choice for exams takes place at the end of the third grade. The pupils were asked about their intention to choose physics. The distribution about grades and schooltypes was as follows:

Table 2 **Choice of physics (% of n)**

	sse-3		jse-3		jse-2	
Choice	girls n=23	boys n=22	girls n=9	boys n=11	girls n=33	boys n=36
no	61	50	33	36	61	33
don't know	09	--	11	--	27	22
yes	30	50	56	64	12	44

Note: sse-3 = senior secondary education grade 3
jse-3/2 = junior secondary education grade 3/2

We see that in the third grade of both school-types there are still some girls who hesitate whether or not to choose physics but there are no boys that hesitate. Most of the hesitators are in grade 2 of junior secondary education.

We thought it might be interesting to look at gender-differences within groups of choosers, hesitators and non-choosers.

Figures 1 to 10 show the means on most recent marks and the scales against choice for girls and for boys. The outcomes of this analysis can be summarized as follows (note that the numbers of hesitators are small however):

- Mean (most recent) marks are alike for girls and boys within choice-groups;
- Boys think better of their ability in physics than girls, in all choice groups;
- Girls that want to choose physics like it as well as boys that want to choose physics. Non-choosers dislike physics, girls more than boys (p=.056);
- Boys feel a bit more self-confident in physics lessons than girls, choosers feel most self-confident, non-choosers and hesitators are more neutral;
- Boys are more optimistic than girls about what the teacher thinks of their ability. Even girl-choosers perceive their teacher's opinion slightly negative.
- Girls and boys think alike about the didactical qualities of their teacher within groups of choosers and non-choosers. However girls that hesitate are most negative and boys that hesitate are most positive about the didactical qualities of their teacher. If we restrict ourselves to pupils in grade 2 of junior secondary education the pattern becomes even more pronounced. Even for these small groups the effect is significant.
- Teacher's perceived stereotyping of the importance of physics shows another pattern than the other 3 scales that have to do with stereotyping. It is the only scale for which the means for boy- and girl-hesitators are not reversed compared with choosers and non-choosers. Also boy-choosers are least "unstereotyped" and girl choosers are most "unstereotyped".

Conclusions

Conclusions must be drawn with regards to further research. As for the pupils questionnaire: It is not yet complete with regards to the specific learning experiences, information and role-models the teacher provides (or does not provide) and the feed-back the teacher gives (all variables in Eccles' model):

There are only two rather generally formulated items concerning respectively the relevance of physics and the societal value of physics, both variables that are considered important in relation to gender-differences.

Trying to measure stereotyping opinions and behaviour of teachers by explicitly asking the pupils using a questionnaire may not be such a good idea. Pupils will deny such opinions and behaviour. An alternative approach may be to ask the pupils after the content of denigrating remarks and the recipients of such remarks and to study the relations of an extended version of the "diligence"-scale with other variables. Asking the teachers about their expectations etc. of individual pupils also provides useful information about possible stereotyping opinions and practices, as we have seen.

The specific contents and character of physics are not represented in the questionnaire. It might be interesting to include items concerning the contents and character of physics (as it is presented by the teacher in the physics lessons) in both the teacher and the pupil questionnaires and relate these to pupils' experience of physics. For instance it has been shown (in the Netherlands by De Leeuw) that there are large gender-differences in the appreciation of physics contents and that physics teachers predict the interests of boys when asked to predict the interests of pupils. What this means for their actual teaching practice has still to be sought out.

The large gender-differences amongst hesitators on perceived didactical quality of the teacher need to be clarified. Is this a general phenomenon or a coincidence? Are there maybe other variables interfering as well?

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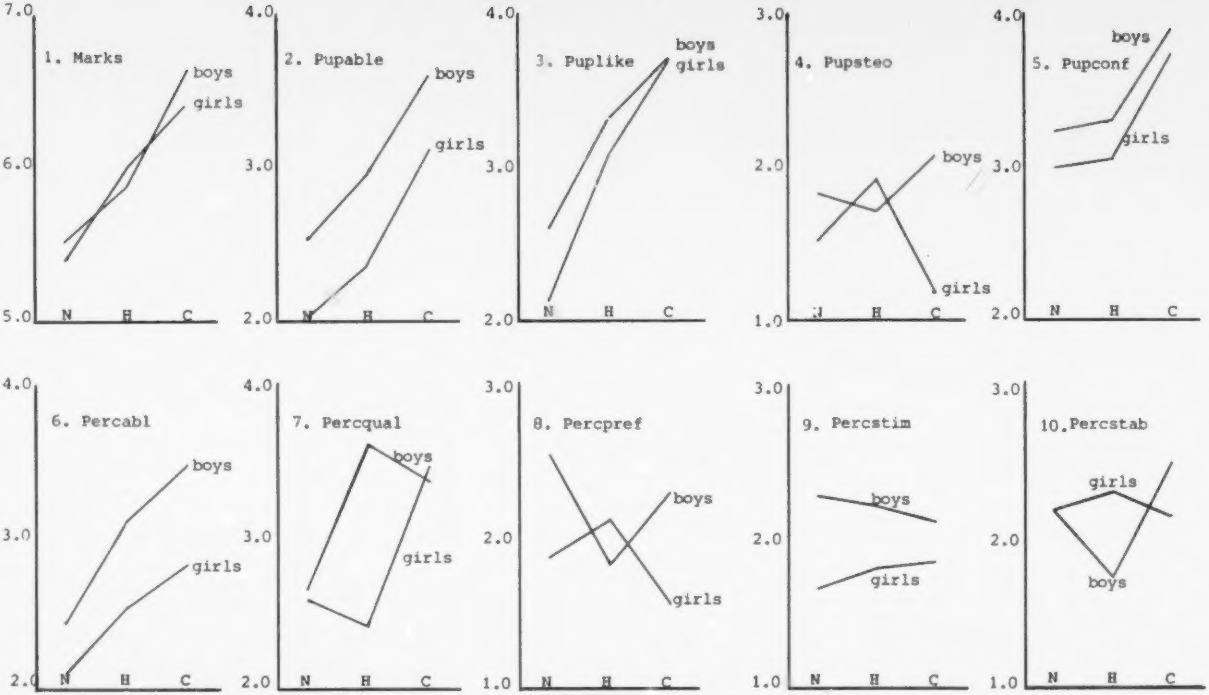

N: Non-choosers girls n=31-35, boys n=23-26 H: Hesitators girls n=9-12,boys n=7-8
C: Choosers girls n=13-15, boys n=32-35

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GIRLS' EDUCATION IN SCIENCE AND TECHNOLOGY AND THE AFFECTIVE FACTORS IN A NIGERIAN BACKGROUND

BY

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ABSTRACT

A random sample of 438 girls was made from seventeen co-educated schools and seven single-sex schools and studied. The basic correlates of some selected variables were looked at relative to classified affective categories in science and sources of scientific information.

Girls' affective outcomes were found to be greatly influenced, in a positive manner, through their education in single-sex schools, schools located in urban areas and schools with well equiped and used laboratories.

The Difficulty/Easiness of science was a significant correlate to school ownership and girls in Government owned schools seem to contend that science is easier to learn than those in Voluntary Agency schools.

Girls' enjoyment of science and science lessons correlated highest with their attitudes to 'science books' (.80), followed by 'science practical work' (.66), 'science teacher' (.47) and 'scientists' (.41).

INTRODUCTION

Ormerod (1973) defined attitude as 'a state of preparedness to learn or not to learn', and Tolpin (1971) urged that we should be concerned with attitudes and emotions of the student towards science because 'curiosity and drive for continued learning are dependent on attitudes and emotions'. Gardener's (1975) descriptions of attitudes to science as 'interest', 'satisfaction' and 'enjoyment' are thus basically essential. There is need therefore to measure the attitudes of females to several aspects of science with a view of improving their affective outcomes in their education in science and technology.

THE APPROACH

The study looked at the relationship between the identified variables and females' attitudes to both science and some sources of scientific information. The criterion measures are the scores obtained on the attitude scales developed and validated by Ato (1981), Ato and Wilkinson, (1979, 1982) usage made of scientific equipment was measured for each school using a specially constructed equipment schedule (details of construction and reliability studies are given by Ato (1981) Ato and Wilkinson, (1986).

The student variables considered included age and year of study (form). The school variables included type, (girls only or mixed), location (urban, rural) ownership (Government, non-government) and usage made of scientific equipment (low, high).

For teacher variables a scale was designed mainly to measure attitudes towards the science teacher as a source of scientific information and included in the battery of attitude scales. The sampling procedure employed ensured that the differential effects of

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teachers and their methods would be counter-balanced as much as possible.

Eleven 'attitude to both science' and 'sources of scientific information' scales were used. The aplit-half technique employed, with a Spearman-brown correction, gave reliability co-efficients ranging from 0.60 to 0.90.

The attitude scales were administered to a stratified random sample selected from 24 secondary schools in Benue State (N = 438).

ANALYSES AND RESULTS

The data were analysed using several statistical analyses namely, correlation, 't' tests and multiple regression.

To see which 'student' and 'school' variables contributed most to the prediction of the attitudes to both science and some resources of scientific information, step-wise regression analyses were undertaken. The results of these analyses are given in table 1.

TABLE 1

Multiple regression: Step-wise Solution as to the most important variables predicting females' attitudes to science.

Attitude dimension	Order of entry of the student and school variables in regression equations	
Enjoyment of science and science lessons	1. School type 2. Form 3. Ownership	4. Equipment 5. Location
Social Implications of Science	1. Location 2. Equipment 3. School type	4. Age 5. Ownership 6. Form
Attitudes towards scientific inquiry	1. Location 2. Form 3. Equipment	4. School type 5. Ownership
Career Interest in Science	1. Form 2. School type 3. Age	4. Location 5. Equipment
Leisure interest in Science	1. School type 2. Location 3. Ownership	4. Form 5. Equipment 6. Age
Objectivity in Science	1. Location 2. Form 3. Equipment	4. Age 5. Ownership
Difficulty/Easiness of Science	1. Ownership 2. Age 3. School type	4. Location 5. Equipment 6. Form

The relative contribution of the various measures of sources of scientific information to each of the student's attitude to science dimension was made out using multiple regression, step-wise solution. The results are given in Table II.

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TABLE II

Multiple Regression: Stop-wise solution to the relative Importance of the sources of scientific information as predictors of females' attitudes to science.

Attitude Dimension	Order of entry of the sources of scientific information in regression equation	
Enjoyment of science and science lessons	1. Books 2. Teachers	3. Practicals 4. Scientists
Social Implications of Science	1. Scientists 2. Books	3. Practicals 4. Teachers
Attitudes towards Scientific inquiry	1. Practicals 2. Scientists	3. Teachers 4. Books
Career interest in Science	1. Books 2. Scientists	3. Practicals 4. Teachers
Leisure Interest in Science	1. Books 2. Scientists	3. Practicals 4. Teachers
Objectivity in Science	1. Scientists 2. Practicals	3. Teachers 4. Books
Difficulty/Easiness of Science	1. Books 2. Practicals	3. Teachers 4. Scientists

In addition the perason Product-moment corrlation was computed using the SPSS, to ascertain the relationship of the sources of scientific information with students' attitudes towards science. The results obtained are given to Table III. All the attitude to science scales correlated significantly at the 1% level but objectivity in science showed no significant correlation with the 'science teacher'.

TABLE III

The Correlation Matrix for the Contribution of Sources of Scientific Information to attitudes towards science of Females

Attitude Scales	Scientist	Teacher	Practical Work	Books
Enjoyment of Science and Science lessons	.41	.47	.66	.80
Social Implications of Science	.55	.35	.53	.54
Attitudes towards Scientific inquiry	.36	.25	.37	.30
Career Interest in Science	.41	.40	.62	.75
Leisure Interest in Science	.45	.33	.62	.69
Objectivity in Science	.30	NS .05	.21	.15
Difficulty/ Easiness of Science	.22	.31	.49	.52

NS = Not Significant. The rest (P∠.01)

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The relative contribution of composite of 'student' and 'school' variables to the variance of females' attitudes to both science and some sources of scientific information was established by computing two sets of regression equations. In one set the student variables (age, form) were entered first in the equations and followed later by the school variables (location, type, ownership and equipment usage). In the other set, the order was reversed to enter the 'school' variables first and the 'student variables later. The differences between the two values of the R^2 were then calculated. The significance of the difference between the R^2 value of each set of variables was made and importance attached to the set with the higher R^2. The results obtained are given in Table IV.

TABLE IV

The Significance of the R^2 difference between each set of student and School Variables when either set is entered first in the multiple Regression Equation for the prediction of females' attitudes to both SCIENCE AND SOME SOURCES OF SCIENTIFIC INFORMATION

Dependent Variable	Independent Variable		
	R^2 Difference	Set Higher	F
Enjoyment of science and Science lessons	.014	School	2.
Social Implication of Science	.056	School	7*
Attitude towards scientific inquiry	.057	School	7*
Career Interest in Science	.017	Student	4.5*
Leisure Interest in Science	.043	School	5.5*
Objectivity in Science	.055	School	7*
Difficulty/Easiness of Science	.007	School	1
Attitudes towards scientists/ Normality of Scientists	.068	School	8.5*
Science Teachers	.014	School	2*
Science Practical Work	.030	School	4*
Science Books	.021	Student	5.5*

*Significant at .01 level.

The SPSS sub-programme 'T-Test' was employed to establish the significance of 'school' and 'student' variables in students' attitudes to both science and some sources of scientific information. The results obtained are given in table V.

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TABLE V

The significance of school and student variables in students' attitudes to both science and some sources of scientific information. (t analyses)

Dependent Variable	Independent Variable					
	Age	Form	Location	Type	Usage	Ownership
Enjoyment of science and science lessons	NS	<.01	NS	<.01	NS	NS
Social Implications of Science	NS	NS	<.01	<.01	<.01	NS
Attitudes towards Scientific inquiry	NS	NS	<.01	<.05	<.01	NS
Career Interest in Science	NS	<.01	NS	<.01	NS	NS
Leisure Interest in Science	NS	NS	<.01	<.01	<.01	NS
Objectivity in Science	NS	NS	<.01	NS	<.01	NS
Difficulty/Easiness of Science	NS	NS	NS	NS	NS	<.05
Attitudes towards scientists/normality of scientists	NS	NS	<.01	<.01	<.01	NS
Science Teachers	NS	<.01	NS	<.01	NS	NS
Science Practical Work	NS	NS	.01	<.05	<.05	NS
Science Books	NS	<.01	NS	<.01	NS	NS

The same variables in this study influence some attitudes differently from other variables. Some variables seen as most important in certain attitudes are least in others. (See table I,II.).

DISCUSSION:

Before results from any kind of attitudes scale are assessed, a warning may be necessary (Ormered and Duckworth 1975). The physical scientist can usually carry out investigations by holding all known sources of variability constant except for those under consideration. This ideal procedure is often impossible in science education. The present study encompassed attitudes scales with specific theoretical construct (Ato, 1981) that made for clearer picture of how the investigated variables might be linked with each other and with the affective outcomes in science and some sources of scientific information of females.

The results of this study generally suggest possible influence of maturation and socialization, the effects of increased experiences with science or the hierarchical presentation of science subject matter in schools; teacher-classroom behaviours and availability

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and use of science equipment (see Table V). The suggestions given here for the improvement of females' attitudes are based not only on these possible influences but also from the literature. They therefore need to be investigated to obtain greater insights into them.

If we can assume that attitudes are not innate but learned, we must also assume that a positive attitude can be taught (Shrigley, 1978). Two lines of action are necessary (Ormerod and Duckworth, 1975), namely specific efforts to irradicate undesirable attitudes and the misconceptions on which they are based. Further efforts are needed to put more desirable and rational attitudes in their place. We teach far more than the subject matter of our lessons, and if we are conscious of the ways we are doing this, we are more likely to bring about the ends we desire than if we trust to blind intuition (Evans, 1965).

Secondary school science teachers are capable of substantially changing females' views of science (Bottomly, 1981) and the science teacher should be the most important resource in science education (Ingle and Jannings 1981). The key to success lies in the hands of teachers in the classroom (Ingle and Jennings, 1981). It is only they who, when all is said and done, will discover the means of making science stimulating to a wide variety of students at every stage of their schooling. This calls for adequate teacher training which is a major responsibility of the Government.

It is important for teachers to provide students with a balanced view of the benefits of and the problems raised by scientific advances. This social dimension should become an integral part of science courses and teachers in other fields should also be encouraged to foster the social aspects of science. There is need for curricula which emphasize the social aspects of science (Korth, 1969) and positive defence of science against superficial slights about its dangerous nature should be undertaken by way of providing science education with less emphasis on content but more on its social implications pointing out the likely consequencies of life without it (Ormerod et al, 1979). Schools need emphasize science as a human activity (Ingle and Jennings 1981). Student-teachers improved their views of the nature and language of science after offering a course in the history and the philosophy of science (Ogunniyi, 1983).

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Teachers' classroom behaviours show more interaction with boys or bright kids (Fower 1973) and the answer here (Kelly A. 1981) is for the teacher to monitor his or her behaviour very carefully, being conscious of the ways in which differentiation takes place is the first step towards diminishing it.

The Magnitude of 'school' variables in explaining the variance in Girls' attitudes to both science and some sources of scientific information (see table IV) supports the fact that girls are more influenced by their teachers than boys (Johnstone, 1974), Girls tend not to be given encouragement in acquiring independence (Baumrind, 1972) and because of this they are more dependent in the presence of people and even very bright girls are less confident. This lack of confidence may then result in girls depending more on what goes on in schools than anything else. The results suggest that school-based strategies are most important in modifying girls' attitudes to science and de-stercotyping in the classroom (Whyte 1981) could prove useful. Discovery appropaches in science develop more positive attitudes towards science (Tamir, 1979). Practical work done by students themselves leads to greater improvement in both achievement and attitudes (Ramsay and Howe, 1969). The use of laboratory assistants helps in improving students' attitudes towards practical work (Rosier, 1974). More positive attitudes towards experiments occur in classrooms perceived as more satisfying (Fraser, 1978).

The difficulty of science requires that (Ormerod, 1981) science syllabuses be revised to better the situation, particularly that of girls and the level of difficulty must be reduced to bring physical science into line with other subjects (Ato, 1986). The difficult material should also be looked at in science books every effort needs to be made to produce science books with a total Nigerian background. Difficulty-easiness of science is found to be strongly related to 'Science books' in both boys and girls (Ato, 1986) and it is suggestive that student variables (age, form) lead towards better comprehension of science books. This is moreso in that 'difficulty with language and vocabulary has been identified as one of the causes of difficulty with science (Ormerod and Duckworth, 1975). In addition the understanding of scientific principles has been noted to be related to age (Wilkinson, 1975).

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There is some sense in maintaining girls' schools alghough schools newly established are mostly co-educational and this would seem to accentuate the girls' situation (Ormerod, 1981).

There is also need for making students more conscious of career opportunities in science (Dillon and James, 1977). Lectures about women scientists are more effective in improving girls' attitudes towards scientific careers than talks about career opportunities for women in science (Raskin, 1968). The fact that younger girls show more favourable attitudes towards career interest in science supports the fact that socialization of girls influences their attitudes to science (Ormerod and Duckworth, 1975). Also girls' perception of their future roles within marriage is very important (Hutchings and Clowsley, 1970). The results show that younger girls who are not yet at the age of marriage show more interest in science careers but this is not the case with the older ones who reached the age of marriage. The results warrant a suggestion that the critical ages at which girls' attitudes to career interest in science could be profitably influenced may lie within the pre-puberty period. There are relatively few girls who can suspend thoughts of marriage for a time and experiment with the same freedom as their male counterparts (McRobbie, 1978). Two lines of action are suggested to counter 'adolescent feminity' (Kelly, E. (1981) namely:

1. Cross-sex activities and interest need to be developed and encouraged from the first days of school and right through education and,
2. Parents and teachers need to work together to develop alternative models of adolescent sexuality to which young people can relate.

A comprehensive consideration of the issues raised will certainly improve the education of females in science and technology.

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Girls and Science and Technology European and

THIRD WORLD CONFERENCE 6th-11th MAY, 1990:

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EDUCATIONAL MODELS OF CHANGE: HOW THEY CAN CONTRIBUTE TO GASAT.

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(This paper is about an Australian Project and work)

(The Girls and Maths and Science Teaching Project (GAMAST) was an Australian project funded by the Commonwealth Schools Commission (1986-1988) to develop a set of workshop activities for teachers to change their classroom practice. The McClintock Collective is a Victoria, Australia, based group of science educators who have been working collaboratively since 1983 to increase the participation of girls in science education and to reform science education for both girls and boys.)

BACKGROUND

Much of the work outlined here is more than the work of a few, it is the collective experience of a group of teachers. These ideas and this process belongs to them too; one of our strengths has been maintaining our working collaboratively approach which has been difficult at times in a system which often asks for leaders to be assigned and hierarchies to be established.

The McClintock Collective started by organising awareness raising inservices which focussed on sexist classroom practices and sexist resources in science education. As a group of female science teachers we acted largely from intuition about what was lacking in science education programs and why they were unattractive to female students. We started designing curriculum and inservice programs and quickly moved to an emphasis on the way science is taught. Our central questions are: what sort of science and science teaching do we want for both girls and boys, and how can educational change be most effectively organised? It is easier to see our change pathway in retrospect. The Girls and Maths and Science Teaching (GAMAST) project was a Commonwealth Schools Commission Project of National Significance funded throught the Victorian Ministry of Education. The GAMAST project was built on the work of the McClintock Collective. The focus of the GAMAST project was to plan, trial and write a professsional development book for teachers in maths and science, which would provide a resource for other gender inservice programs in Australian schools. This manual has been published as "Gender Equity in Mathematics and Science" (Lewis and Davies1988).

THE OVERLAP BETWEEN SCIENCE, GENDER AND EDUCATION

Reforming science teaching to be more equitable and empowering for girls and boys is a complex and human process as it requires dialogue and understanding between educational perspectives, feminist and social critiques of science, and the sociology and psychology of gender. What programs can we offer to produce effective change in teacher practice? What program designs are the most likely to produce lasting and significant changes in our teaching? What is the patriarchal nature of science itself and what are the social forces that have influenced its methodologies and practices? What are the social experiences and expectations of girls and boys in childhood and the way these experiences influence their learning styles and informal science knowledge when they arrive in our classrooms? These are all questions that are common to most of the GASAT community. The questions concerning the social construction of gender and science are addressed in other GASAT resources and this paper explores the questions of educational change as they relate to science education and gender. The challenge is to understand parts of this jigsaw in our local groups and to share these ideas more widely to learn from one another. The GASAT community is exciting as it is a powerful forum for this exchange at an international level.

The focus and content of gender and science professional development programs requires increasing emphasis if we are to sustain the momentum and effectiveness to produce change. There is a tendency in Australia for the latest "new" direction in science education to attract funding for a few years and then disappear from government funding guidelines. Gender and science projects are in danger of this neglect and misunderstanding.

CHANGING SCIENCE NOT GIRLS

Developing an inservice program which has a clear purpose to enable girls to actively participate and experience success in science, presupposes a "list" of teaching strategies to achieve this as well as a clear definition of the sort of science education we want for girls and boys. Translating many of the critiques of the practice of science into classroom practice is a difficult process to conceptualise and implement. The work of the McClintock Collective provided the basis for the teaching strategies. We have been brainstorming, developing, practising and evolving a set of teaching strategies in the McClintock Collective since 1983 (Getting into Gear 1989). Early planning in the GAMAST project focussed on the vision of the classroom science that we were aiming to achieve.

TOWARDS AN INCLUSIVE SCIENCE

Whilst society continues to treat girls and boys differently in childhood, then school science has to recognise the different background experiences of not only girls and boys, but students of different cultural and class backgrounds. Some students have had parents who assist them with science equipment, experiments and discussions at home whilst others have had little or no exposure to the languages or processes of the physical world. Many children are subjected to environments where learning is secondary to economic or emotional survival. The inclusive science that we have been developing recognises in its teaching practices the different starting perceptions and backgrounds of students without a judgement about these differences. It also facilitates classroom experiences for girls and boys to acquire more familiarity with skills that were not part of their gender construction, provides the contexts for students to connect science to human concerns and provides entry points to learning that have a social context familiar to both girls and boys.

From these teaching styles we can develop classes where neither female or male background experiences are valued over the other and both female and male learning are extended by school science. Ultimately we may contribute to a new generation of science teachers and scientists who contribute to reconstructing science as a co-operative and human activity. Two classroom scenarios follow to illustrate the transition from traditional to inclusive that we have been developing.

MARIA'S TRADITIONAL SCIENCE CLASS

This class profiles a traditional Australian science class that may be familiar internationally also. The teacher is called Maria and a female name is important as it is not only male science teachers we are concerned with; it is the women and men whose training and science experience are very similar. Maria has just arrived at Androgen High School where she has been given a year 10 science class with 25 students as part of her teaching allocation. She was trained at Melba University majoring in Chemistry and she has given a lot of thought to course design and students' interests in her teacher training. Maria is presented with this class of 25 plus the syllabus in which the first topic listed for term 1 is chemical reactions.

Maria starts her first class by putting up the title of the topic, giving out some notes, defining terms, describing what the unit is about, revising chemical names and processes, outlining the sections of the unit on electronic configurations, stoichiometry, the mole concept, valency and bonding. She then starts talking about potassium, carbon, oxygen, terminology that the students will probably be hearing about for the third or fourth time depending on their previous experience.

This class could alternately be on light, electricity, forces. The common denominator in this approach is starting from the concepts, major ideas, models, theories and content appropriate to the body of knowledge called science.

Maria cares about her students and she thinks practical work is an important part of the course. Out comes the silver nitrate and the potassium chloride for the first experiment. She writes the aim and method up on the board in full, leaves the results as a gap for the students to fill in and gives them a set of instructions to go ahead and do the experiment. When it is 5 minutes to the bell time the whole class gets drawn back together and there is a quick discussion. Maria is worried about the time so she picks on the student who will give the most accurate and rapid answer because of the rush to the bell. Paul makes a quick conclusion about the reaction and the products. As the students are rushing for the door, Maria asks "Can you think of any applications?" There is some textbook reading and problems set for homework.

This is not meant to be critical of Maria but rather a realistic outcome of the training and expectations on teachers to conform to the way that science has traditionally been taught.

WHAT ARE THE CHARACTERISTICS OF THIS TRADITIONAL CLASS?

The characteristics of this class are: notes were issued; the class started from the abstract; the teacher assumed that the students had no opinions, ideas or views on the topic; the teacher designed the experiment herself; tested using recall, memory, multiple choice questions; found out the students misunderstandings too late or did not find them out at all; and rushed on to the next topic. What is wrong with all this? What is it that has locked so many girls and boys out? This is the sort of science education that produces unequal participation particularly in the physical sciences. What Maria is doing is emphasising formal operational thought, abstraction, conceptual cognitive levels, and most likely leaving many students out of the learning game by doing that. There are also classroom dynamic issues where there is differential attention given to girls and boys.

These classes are also where the teacher knows the answers, the teacher is the expert, there is little or no consideration of the quality of learning, there is little regard for the interests and concerns of 14 year old girls or boys. Science is instrumental, cold, value free and there is no process applied in the classroom that would empower the students to go about investigating something else independently. Boys do not enjoy this process any more than girls: our survey work showed that girls listen to their interests more than boys when they decide their future subjects.

MARIA'S INCLUSIVE SCIENCE CLASS

Now to the science classes that we are learning about and the vision that we have tried to move towards during this project. Another scenario! The teacher, Maria again, comes into the year 10 science room which is crammed with student mobiles, posters and models. The students work in groups and they are familiar with working in groups that are sometimes structured. The students brainstorm questions, and then make their own categories for reactions and changes involving chemical substances that they know of. What happens to an Alka Seltzer tablet? What happens to toothpaste when you use it? What happens to a match when you strike it on a match box? What happens to shampoo when you mix it with water? Why does red cabbage change colour? What happens when a cake changes from solid to liquid during cooking?

From this list of questions about these changes, Maria comes up with an outline of the areas that the students want to investigate. These categories of student interest are then used to design the unit. Maria designs a pre topic test on these questions so that students can assess their learning during the unit by redoing the same test on completion.

From that initial brainstorming, the students design and carry out their own investigations in groups. For example some students investigate Alka Seltzer reactions with tablets, glasses, water at different temperatures, thermometers. After they design an investigation as a group, they discuss this with Maria and other students. What are their expectations and predictions of their experiments? They do the experiments they have designed, observe what happens and come up with ideas, models, theories, hypotheses to explain what they have found out as a group. The students check out their ideas with Maria, other teachers and students as well as books. Maria asks them to present these ideas to the next class using any one of a variety of presentations. Some choose as a group to write up the practical in the first person, pretending they are the Alka Seltzer and describe what happens to them. Some choose to role play a packet of Alka Selzer to the rest of the class. Others write a newspaper article for other students in the school to display and describe their ideas. Others design and present a poster or a model or a concept map. There is a whole range of communication styles possible rather than the "aim- method- data- conclusion" type of practical report. From these class presentations Maria facilitates class discussions and at intervals asks students to write individually on their learning and reflect on how their group has worked. Students are being asked to think, talk and reason. Talking is very important as a way of personalising learning.

WHAT ARE THE CHARACTERISTICS OF THIS INCLUSIVE CLASS?

This way of teaching often takes more time, as you cannot rush through the syllabus in the same amount of time. The compensation is in terms of increased student learning and participation. What are the characteristics of this classroom? Understanding is not separated from students prior understandings and beliefs. All students hold some personal view of the topic prior to classroom experience. The misunderstandings and perceptions can be treated in terms of information rather than correct or incorrect responses. The situation in which the learning happens is valued as well as the actual learning. Often the concepts can be recalled through the context in which it was learnt. For example, when students have acted as an Alka Seltzer in a science class they will recall the event linked to the understanding. It is personal and part of their experience of the world.

One of the most important characteristics conveyed by this sort of science teaching is that science is a process of understanding the world. It is one way of knowing. It is a process whereby you can collect bits of information about the world, make sense of it, and help you to interpret more about your world. It is also concerned with values and social issues. The relationship between students and their teacher is different when the teacher is no longer the expert and director.

In summary, this change in science education starts from the experiences and interests of students and moves to the scientific ideas and understandings. It is an issues or interest driven curriculum rather than content driven curriculum. It is this fundamental curriculum reorganisation that is important. From these traditional and inclusive scenarios we obtain a vision of what an inclusive science classroom would include. Through this vision we can identify the characteristics of such a learning environment (Fig 1). Getting into

FRAMEWORK FOR AN INCLUSIVE SCIENCE
(Fig 1)
(All of these categories are interdependent and overlapping)

ACTIVE LEARNING CONTEXTS

Creative writing
Drama
Problem solving
Investigations
Building models
Talking
Media
Simulation contexts

CLASSROOM ORGANISATION

Group work
Cooperative group work
Equal sharing of resources
Aesthetic physical environment
Team teaching

REORGANISATION OF THE CURRICULUM

Learning contexts of girls and boys
Starting from and valuing students experiences, understanding and curiosities
Science as a human activity - starting from the issues that connect with students lives and interests
Integration of career perspectives

STUDENT/TEACHER INTERACTIONS
Sharing power in the classroom
Non sexist language
Fostering non-competitive approaches
Atmosphere of honesty, humour, co-operation
Tolerance and conflict resolution skills
Building students confidence
Negotiation of tasks, activities

Gear (1988) has a more extensive description of the inclusive teaching strategies. The Student /Teacher Interaction column in this diagram continues to be the most difficult part of our inservice work, because it relates to factors that we are convinced are integrated into the other approaches but are difficult to directly address in inservice programs. They relate to personal change issues and less to what has traditionally been identified as educational change.

LEARNING ABOUT CHANGE

During the GAMAST project, our energies were focussed on the participating teachers defining the issues for themselves, starting from their understandings and perceptions, providing them with the opportunity to learn different teaching strategies and assisting teachers to establish a collaborative process for incorporating these changes into their teaching.

Many staff development programs are disconnected from the process of change. As the project proceeded, we understood more about change and how it relates to teacher practice In retrospect, more activities about the process and difficulties of change would have been valuable to explore with the participating teachers. We came up with a series of guidelines based on the collective influences of a number of research perspectives on educational change and action research. Also in hindsight, it seems clearer that change itself is a learning process for teachers. GAMAST tried to assist the teachers to see change as an ongoing activity generated within the school by the teachers. There was no "shoulds" and "musts" but a recognition that change processes are often irrational and unpredictable and can be more comprehensible after the change process has taken place.

These GAMAST guidelines were:

> there are particular issues relating to girls which must be addressed when teaching science;
>
> change is necessary but happens slowly;
>
> working in a group provides support and an avenue for exchange of ideas which facilitate change;
>
> teachers need to find time to observe, plan, act and reflect on their practice;
>
> action research is a successful model for initiating and undertaking change;
>
> outside assistance from people such as equal opportunity or science consultants can be invaluable;
>
> small amounts of money for resources are essential;
>
> documentation is a very important aspect of the process: for the teachers involved, for the school, and for dissemination to other teachers and schools;
>
> if teachers are provided with an opportunity to personally experience new strategies, they will find it easier to transfer the ideas into practice. (Lewis and Davies 1988)

One of the characteristics of the GAMAST project was the forming of group or teams of three teachers in each of the primary and secondary schools. These groups of teachers were given the equivalent of a day per week time release; half of this time was spent working together as a group.

SOME OF THE RESEARCH INFLUENCES ON THESE GUIDELINES

Like other staff development programs, our project wanted to effect change in three main areas: classroom practice or **behaviour** as teachers, our **attitudes** as teachers, and the **learning outcomes** of students. The order that these processes occur is of fundamental importance to inservice design and change management. Early models of the process of teacher change started with the challenge of changing teachers beliefs, **attitudes** and perceptions. This theory proposed that changes in teacher **behaviour** and classroom practice would follow. The work of Guskey (1986), Fullan (1982), and Joyce and Showers (1981) hypothesise a changed view of the sequencing of this process and the approaches within inservice programs. The emphases are on providing opportunities for change in teachers classroom practice ie **behaviour** and that any subsequent change in the **learning outcome** of their students will produce a change in internal beliefs and **attitudes**.

Guskey (1986) outlines the implications for staff development that arise from this model. Programs need to recognise that change is a gradual and difficult process for teachers and that learning and implementing something new are time consuming as well as anxiety producing. Adding a drama activity for the first time to your teaching means to risk failure and chaos; both very threatening and potentially embarassing. Designing a brainstorming activity at the start of a lesson may be less risky. The chance of a teacher implementing a new approach depends on their perception of the magnitude of the change from their current practice. Within the project team time, there was a significant amount of time spent planning how the new practices could be implemented step by step.

During the team time, teachers included strategies for assessing the impact on the students of the changes to the classroom. This ranged from subjective perceptions of how students enjoyed planned classes and student assessment sheets, through to the student survey work that the project evaluation team conducted and discussed with teachers. All of these modes were important for the teachers and the project staff to reflect on the effectiveness of new lessons. Guskey (1986) advocates that plans for implementing a program should include procedures so the teachers can receive evidence of the effectiveness of their efforts. In GAMAST, we preferred these to be teacher designed and they often linked up with the changed assessment strategies that the teachers were implementing.

The incorporation of teams of teachers in each school working regularly together with the project staff, provided the continued support and follow to implement new approaches. When the teachers were implementing a new strategy, such as co-operative learning, they had specific concerns and doubts that could be discussed in the team time. The team approach was an ideal environment to think through solutions and obstacles that arose for teachers. When a teacher felt that a class was a "complete failure" the team time provided a place for joking about it and modifying the implementation of the strategy. Joyce and Showers (1981) use the term coaching to describe the personal process of assisting teachers to adapt the new practices to the needs of their students and helping them to analyse the effects on their students. In practice, much of this continued support and encouragement was provided by the teachers for one another. It was the experience of the GAMAST project that this component of the design was one of the most successful aspects of the team time.

ACTION RESEARCH CONTRIBUTION

Action research was a powerful tool in GAMAST for providing the teachers with a framework for changing and developing their teaching. It has been a social and educational research method that has been widely used since the 1960's for people working collaboratively to improve their practice. Research has too many images of the expert as the removed academic collecting data in isolation. Perhaps the most useful message from action research in the GAMAST project was that research is a tool for everyone to become more informed about their situation (Brown(1981), and Carr & Kemmis (1983)). All of the questions that the teachers asked about their school situation were addressed by using action research. Action research is traditionally a technique for whatever issue the participants identify as a priority, but in the GAMAST project we assumed the starting points as girls and maths and science issues. Some of the contradictions with the inservice work in the gender and science area is that the direction of the change is predetermined by funding, and the need for curriculum reform in response to sexism in science teaching and curriculum. We were not saying "consider any change that you want to make" and in GAMAST, as in other gender and science projects, the participants were self selecting for their interest and concerns.

Action research has four central phases: **planning** where a decision is made about the research question and a course of action is planned; **acting** in which the plans are carried out; **observing** which concentrates on the analysis of the action and **reflection** where an understanding of the observations is developed and new plans are made (Brown (1981)). In practical terms our project translated these theoretical ideas and guidelines into a two phase project: a short initial phase of team building, identifying classroom and school issues and determining the design of the innovation followed by a longer teacher practice phase where the focus was on change in classroom practice. Both of these phases incorporated some of the action research principles.

An example of an action research process that a group of teachers in one school investigated during the first phase was "Do girls participate in our school science programs as much as boys do?" The group planned the tasks and the techniques for collecting the data. This involved finding the class lists from all the year 11 and 12 teachers and collating the data together. The group met again and observed that girls were not participating in the school science programs, and in particular the physical sciences, to the extent that boys were. This then prompted a discussion of why girls participate less and some plans for what the school could do about this. For some teachers this was a revelation that there was any difference in the participation of girls and boys in their school. This data collection phase varied in length from one month to 6 weeks as the groups of teachers went through their cycles of planning, acting, observing and reflecting. From this phase they identified their own plans for change in their classroom practice.

CHANGING CLASSROOM PRACTICE

During the second phase of the project the teachers developed changes in the classroom practice of teachers and followed a sequence adapted from Joyce and Showers (1981) as well as incorporating the action research process from the first phase of the project. These stages in the following table (Fig3) are based on the example of co-operative learning and recognise that no human change is ever as linear as this model suggests.

Fig 3

STAGE	PRACTICAL CONTENT OF TEAMTIME
Theory/ Demonstration	What is cooperative learning? Video illustrating the technique and teaching contexts Teachers experience an activity working cooperatively themselves. Discussion on the relevance for girls Reading material to take and read
Planning the Trial	Reviewing material for getting started with students Designing own activities for the first lessons with students Practising with the other team members
Feedback / Reflection	Team time discussion of how the first lesson went, what was good and what were the problems? Brainstorm possible improvements
Integration into Teaching	Discuss the application of cooperative learning to different types of science and maths classes eg. practical classes, research, drama, using materials Design classes in subsequent units of work Design evaluation and feedback sheets
Feedback / Reflection	Extensive "success and problem" sessions as the classes occurred Discussion of reading material, ideas Further refinements of individual teaching style

In Victoria, co-operative learning refers to a structured way of organising students into groups with roles, as well as a common task and reporting format for the group. Depending on the data outcomes from the first phase, and the strategies that the teachers decided they wanted to become experienced in, we devised a program and provided sessions both from our own resources as well as from others. We asked a variety of people to conduct sessions with the teachers and often the people visiting provided this first part of the above sequence, so they would input the theory and demonstration of the strategy as well as materials for the subsequent process. For example "what is co-operative learning?" featured a co-operative learning video followed by a hands-on activity using the strategy. The teachers had a direct experience with the stategy first and then they were provided with some reading material and follow up where appropriate.

The second workshop in that area would be planning a trial class for their students and that would involve how to get started, other peoples experiences and ideas as well as the resources we had. First lessons were trialled between the weekly sessions with the students. Next week would start with feedback and reflection on how the class went as well as plans for integrating cooperative learning into the teaching of science and how you could organise practical classes. The feedback and reflection phases were on going. Often there were "problem and success" types of sessions where teachers would describe a fantastic class they had taught in the previous week as well as the sorts of problems and issues they needed to resolve.

OVERALL

In summary, the research ideas about educational change contributed a number of ideas and theoretical underpinnings to explore the theory of change at the same time as implementing change. They have been enormously valuable in furthering our thinking and inservice designs. We did not follow any one theory described in a literal way but found that the combination of ideas as well as the thinking and talking generated was very useful. There are still many challenges to implementing an inclusive science education, particularly one that is free of cultural and class biases as well as gender biases.

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HOW TO GET PHYSICS EDUCATION RIGHT FOR GIRLS

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Summary

Researchers and policy-makers have suggested various ways in which physics education for girls can be improved. In this paper we evaluate the suggested measures by relating them to the outcomes of a longitudinal study carried out among girls and boys during their first and second year of physics education. This study took place in the Netherlands from 1986 until 1989 and focused on the unpopularity of physics as an examination subject among girls in Dutch general secondary education (see also the GASAT-contributions: Jörg et.al. 1987,
Man in't Veld et.al. 1987). Data were collected on four occasions by means of questionnaires (complete data for more than 1500 students (girls and boys) from 63 schools), interviews (data for 32 girls, complete data for 21 girls from eight schools), observations of lessons and a content analysis of the textbooks. In this paper we refer mainly to the results of the analysis of the interviews and the observational data. Our conclusion is that isolated measures are apparently not effective in inducing a higher appreciation of physics education in general nor do they increase the percentage of girls choosing physics as an examination subject. What is needed is a coherent approach throughout the curriculum. We present our findings arranged around three significant aspects of physics education: the perceived value of physics, the difficulty of physics, and the appreciation of teaching methods used in physics lessons.

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HOW TO GET PHYSICS EDUCATION RIGHT FOR GIRLS

Magda Man in't Veld, Ton Jörg, Theo Wubbels

Introduction

The unpopularity of physics as an examination subject among girls in secondary education has been a subject of study and research for about a decade now. In England for instance the GIST-project aimed at changing the attitude of teenagers towards women in science and at stimulating girls to take advanced level courses in science and technology (Smail et.al. 1982). In the Netherlands the MENT-project experimented with some examples of girl-friendly teaching materials (De Leeuw 1987). The measures put into practice seem to be effective in increasing the students' appreciation of the lessons and/or in changing the students' attitudes towards women in science. But the measures that have been tried have apparently had little effect on the percentage of girls choosing physics as an examination subject (Kelly et.al. 1984, De Leeuw 1987). The efforts, which were directed towards changing the attitudes and choices of girls with respect to science, concentrated on: adjusting the content of teaching materials so that it appealed more to girls, changing the prevailing view that science is only a boys' subject and showing girls that science can lead to interesting jobs. Why did these efforts not make more girls choose physics? We shall argue in this paper that more attention needs to be paid to pedagogical-methodological features of the actual curricula, to the teaching methods and to the perceived and experienced difficulty of physics as a subject.

How to get physics education right for girls

A variety of measures have been recommended in the literature. These measures have aimed at: making physics more attractive for girls, increasing girls' appreciation of physics education in general and encouraging girls to opt for physics as an examination subject. The important question is whether concrete measures can change physics education so that more girls are encouraged to choose physics.

The decision to take physics as an examination subject can be considered as an achievement-related choice of individual students, comparable with an occupational or academic choice. Such an achievement-related choice is directly influenced by the expectations for success, the subjective task value and the economic and psychological costs associated with a particular choice (Eccles 1987). This means that a girl's decision to take a further course of physics depends on the expected level of personal achievement, the perceived benefit of the physics course for personal development and future plans and the expected effort required. Several authors concerned with achievement motivation suggest that when girls are aged about 13 their achievement-orientations are quite different from those of boys (Maehr 1983). Girls are believed to be more inclined to demonstrate that they are well-intentioned and cooperative than that they are competent and superior. Physics education however tends to require the students to pursue task and ego goals connected with the competence and superiority orientations. Therefore the girls' orientation towards the social aspects of tasks in general seems to be unfavourable with respect to their achievement level in physics education. When girls have to concentrate on the kind of tasks that physics education imposes on them, they are also likely to have problems. Since they are not used to showing their competence in the way that physics education seems to require, they easily come to feel incompetent. When girls have to make choices with respect to examination subjects, they are therefore likely to turn away from physics.

Recent research and policy reports mention specific measures for improving physics education and science in general (for instance: DES 1980; Mottier 1981; Smail 1984; Kahle 1985; Spencer & Cole 1986; Hildebrand 1987). We can summarize the proposed measures as follows:

- use a more practical and less theoretical approach to the content of physics/science courses and put emphasis on practical work and experiments and on investigations carried out by the students themselves;
- use a concrete introduction to the subject-matter and include a more formal approach gradually;
- pay attention to aesthetic and creative elements and include subjective, personal and imaginative descriptions;
- pay attention to the relation between knowledge of physics and the human body;
- pay attention to the relation between knowledge of physics and the care for and safety of people and their environment;
- pay attention to the way physics/science influences students' lives and the lives of other people and refer also to the history of science;
- pay attention to the relation between knowledge of physics and professions to which girls aspire and give information about the work of women scientists;
- try to link knowledge of physics with problems on which students can express their own opinions.

The main aim of these measures is to make physics or science education more attractive to and more valuable for girls. In this paper we shall discuss the value of the suggested measures, relating them to the outcomes of a longitudinal study carried out among girls and boys during their first and second year of physics education.

The research project and the research methods used

A longitudinal study among girls and boys during their first and second year of physics education took place in the Netherlands from 1986 until 1989. It focused on the unpopularity of physics as an examination subject among girls (see also the GASAT-contributions: Jörg et. al.. 1987, Man in't Veld et. al 1987). In this study we investigated two different curricula for physics education used in the first two years of general secondary education in the Netherlands. Data were collected from two types of schools with different levels of general secondary education. Data were gathered on four occasions by means of questionnaires (complete data for more than 1500 students (girls and boys) from 63 school), and interviews (data for 32 girls, complete data for 21 girls, from eight schools), observations of lessons and a content analysis of the textbooks. Eight schools were selected in which in-depth interviews were conducted. This was done in such a way that we would be able to draw comparisons between schools with an experimental curriculum and schools with a regular curriculum. In order to get indications about whether any other differences between the schools could influence the levels of popularity of physics, we selected two sets of schools: one which had a high percentage of girls choosing physics as an examination subject in september 1986 and one where this percentage was low. At each of the eight schools we interviewed four girls .

The in-depth interviews with girls took place at the beginning and the end of their first and second year of physics education. Each interview was transcribed verbatim and the transcripts were labelled for all the subjects of interest. This work was facilitated by adequate P.C.-software ("The Ethnograph", Seidel et.al. 1988), which enabled us to analyse more than a hundred, initially un-structured, texts. The analysis was done in a way which is comparable with the procedure of the 'grounded theory' approach of Glaser an Strauss (Glaser & Strauss 1967).

Additional to these interviews a small case-study has been carried out at one of the schools cooperating with us in the research-project. This case-study focused on a series of lessons on 'electric circuits'. Six lessons were observed, some of the girls were interviewed afterwards and additional information was obtained from the teacher. Finally we analysed the relevant features of the four series of textbooks in use at the schools in the research project and compared the results of this analysis with the comments that the interviewed girls made about the textbooks.

Experiences of girls with physics education

From the interviews with girls we learned that the following aspects of the experiences of girls with physics education are relevant for our understanding of their changing appreciation of the subject in the course of two years:

- their perception of the value of physics for themselves,
- the difficulty of physics, and
- their appreciation of teaching methods used in physics lessons.

The perceived value of physics

Girls who are receiving their first physics lessons do not have a very well-defined idea about the relevance of physics for themselves, because they have little notion of what physics is about. We found that at the beginning girls were open-minded about physics education. They liked all kinds of subjects and often they wanted to know more about them. We discovered also that different girls disliked different subjects. We found however that some of the larger units in the textbooks were appreciated highly by many of the girls, probably - as we shall point out later - because of the combination of the content and the teaching-method used.

The suggestion in the literature that attention should be given 'to the way physics or science influences students' lives and the lives of other people ...' was elaborated differently in the textbooks used. One textbook in particular relates knowledge of physics to themes which refer to the students everyday environment. In the textbooks written for this method many figures and photographs are showing concrete situations outside school. However we established that the girls interviewed often did not see similarities between what they learned at school and what they came across outside school. For that they needed explicit instructions from the teacher or the textbook.

> " Electric currents are rather boring. You can't do anything with them at home. There aren't any there; sure there's a switch, but that's quite different."

The girls who could give us examples of the ways in which knowledge of physics is applied outside school cited their teacher or their textbooks in most cases.

The suggestions that attention should be given to the relation between 'knowledge of physics and the human body', 'knowledge of physics and the care for and safety of people and their environment' and to the way physics / science influences 'students' lives and the lives of other people ...' appear to be poorly implemented in the textbooks that were actually used at the girls' schools. Our content-analysis of these textbooks showed that the books mentioned apparatus, tools and articles of use much more frequently than persons, the human body, occupations or other human activities. Even the textbooks which present subject-matter around themes on the real life of children appear to refer mainly to objects. From the analysis of the data of the questionnaires we found that girls have a much lower interest than boys in issues relating to objects.

The suggestion that attention should be given 'to the relation between knowledge of physics and the professions to which girls aspire ...' is not elaborated in the methods used for physics teaching. However girls who have to consider the value of physics for themselves often mention that physics may well be important for them in the future. But, for most girls this aspect of the perceived value of physics has lost its importance by time they have to decide whether to take physics as an option for the final examinations.

The difficulty of physics

At the very beginning of physics education the difficulty of the subject is not a serious problem for the girls interviewed. But later on the girls mentioned in the interviews that they were experiencing more and more difficulty in physics lessons. The suggestion in the literature that there should be 'a concrete introduction to the subject-matter and a gradual inclusion of a more formal approach' appears to have been neglected especially in one of the textbooks in use at the girls' schools. At the end of the first year the girls of these schools complained about the difficulty of their textbooks. In the second year many of them did not like physics any more. Their problems with the texts were strongly related to the difficulty of the text and of the exercises and to discouraging tests and low marks. By analysing of the questionnaires we learned that this experience with difficulty induces in the girls much more than in the boys feelings of incompetence and feelings of not being in control with tasks and demands of physics education. This seems to be an indication that girls' positive experiences depend particularly on good textbooks and adequate instruction.

By observing a series of lessons on electricity in one class we were able to discover what happens when parts of the physics lessons are too difficult. At the beginning some of the girls really seemed to enjoy performing the tasks and exercises on electric circuits. In the third lesson the teacher talked about the effect of current on one's body and he invited the students several times to use the word "resistance" in predicting the current and explaining why a high current may occur. Some girls however kept asking about what you feel, when you touch a high-voltage wire or you hang from it with both hands. Afterwards these girls were very disappointed that the lessons were so difficult, and that the teacher seemed unwilling to help them thoroughly. It is interesting how these girls coped with their problems of not understanding the subject-matter: the strategy seems to be rather characteristic for girls. Since the third lesson they had been very disappointed about the difficulty of the lessons. They did not relax their efforts to do their exercises and home-work, but now their sole purpose was to avoid low marks in the final test. They joined a brighter girl and got explanations and help from her to complete the exercises. When interviewed shortly afterwards they stated that they were not at all interested in the subject-matter of physics.

The appreciation of teaching methods

Teaching units in the textbooks that include teaching methods such as students' activities, doing experiments, working in small groups and students' presentations in front of the whole class, can enhance girls' appreciation of physics lessons. This is especially the case under certain conditions which we shall describe.

The suggestion in the literature that 'a more practical and less theoretical approach to the content of physics/science' should be used, that emphasis should be 'on practical work, experiments and investigations carried out by the students themselves' was implemented to a certain extent in the textbooks which we have studied. One of the methods involved activities by the students themselves as a regular element, the other method gives fully descriptions of experiments that were sometimes demonstrated in the classroom by the teacher and were sometimes replaced by activities to be carried out by the students. The girls liked looking at experiments demonstrated by the teacher as well as doing experiments themselves. One of their reasons was that they felt they could remember things more easily after they had seen an experiment or had done it themselves. They would have liked to assist the teacher if they had been asked. The boys however were more eager. Girls also liked to give short presentations for their class-mates if the class-room climate made them feel safe enough. The girls where pleased to get the opportunity to do experiments themselves in small groups, especially if the instructions were clear and if they did not need much help from the teacher. A problem for some of the girls was that they had had very little practical experience even with everyday tools like tweezers and rulers before they came into the physics lessons.

The girls generally liked working in small groups with other girls, but when they had to work together with boys their experiences were less favourable. In mixed groups the girls, who were aged 13 - 15, did not choose or were not given the same tasks as the boys. This meant that they often did not perform certain activities like constructing a circuit with their own hands. We seldom saw teachers effectually trying to alter the distribution of work assignments within a mixed group.

Many girls expressed the need to work with the help of clear instruction from the teacher and well structured textbooks. The textbooks in use at the schools turned out to have different effects on the girls' appreciation of physics. the fact that a textbook is well-structured and provides examples, not too difficult exercises and a concluding summary appears to compensate for contents that at first sight seem unattractive.

The perceived value of physics education and the choice of physics

In spite of the many positive experiences that the interviewed girls mentioned, they appeared to turn away from physics in the course of the two years. They changed their mind about the relevance of physics for themselves, and/or they concluded they did not like physics or they said that they were not getting good results in physics. Some of them felt deeply disappointed at the end of the two years because they had had to learn a subject like physics, which they now felt was not applicable to and not of interest for their own lives. The only girls who finally chose physics when it became optional were the ones who had received both positive and negative advices from various people in their immediate surroundings. They made their choice because the further education they intended to follow for a particular career. They felt able to cope with physics and they had high marks for mathematics. None of the girls we interviewed took physics because she liked the subject.

In our search for examples of the measures suggested in the literature, we rarely came across examples of the remaining suggestions listed above, namely: that attention should be given 'to aesthetic and creative elements and to subjective, personal and imaginative descriptions' and that should be tried 'to link knowledge of physics with problems on which students can express an opinion'.

Conclusion

What can we conclude about measures that should taken to improve the effect that current physics education in the Netherlands has on girls' appreciation of physics lessons and on their intention to choose physics as an examination-subject? The proposed measures for making the subject-matter of physics more attractive and interesting for girls can increase girls' appreciation of physics lessons. However, isolated measures do not seem to be effective in inducing a higher appreciation of physics education in general. A coherent, well-structured and instructive approach throughout the curriculum seems to be necessary. We have arranged our findings around three relevant aspects of physics education. These are: the perceived value, the experienced difficulty and the attractiveness of the teaching methods used.

The perceived value of physics as an examination course seems to depend mainly on the relevance of knowledge of physics and the relevance of a certificate in physics for the girls' future. It is plausible, however, that most girls adjust their future plans to their low expectation of success in physics education (cf. Kelly 1988).

The experienced difficulty of physics lessons is a factor that causes more girls than boys to give up physics. We found indications that girls are largely dependent on the instructions in their textbook and the instructions given by their teacher. When these means of support fail, girls rely mainly upon the help of their female class-mates, whereas boys presumably rely on their wider informal knowledge and pre-school experiences, as has been suggested by Erickson and Farkas (1987).

Teaching methods, practical activities and working in small groups can increase the girls' appreciation of the lessons, especially when the circumstances further the girls' self-reliance and allow them to participate to the same extent as boys. In general girls appear to prefer instructive and well-structured tasks. Clearly structured tasks seem to have a positive influence on girls' achievement motivation. Well-structured tasks help to keep the girls from worrying about what their teacher expects of them. They can therefore concentrate on performing the tasks. This conclusion corresponds to the recommendation of Maehr (1983), namely that students in science education should be stimulated to aim at task goals.

In this paper we have presented the results of qualitative research which enable us to describe the experiences of girls with physics education. If descriptions of these experiences are used as a basis for further research into the construction and implementation of physics curricula we may be able to get physics education right for girls[2].

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WHEN GIRLS DO PHYSICS

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In august 1987 I started a three years project about "Girls and the technical scientific area". I am just now (the start of 1990) working on the final thesis as part of a Ph.D. study. This article will deal with some part of my work. I intend to describe what's going on in the science classroom when girls do physics - and like it.
But as a start I would like to introduce to you the frame in which my project goes on.

Science in the Danish school system (0.-10. grade).

In Denmark we have 9 years of compulsory education from age 7. The pupils may start at age 6 with 1 year preschool and it is possible for the pupils to choose an extra year - and follow the 10th grade.

From the 3th to 5th grade geography and biology are taught together with history as one subject called "Orientation" 3 lessons a week.

In the 6th and the 7th grade geography and biology are compulsory subjects with 2 lessons a week each of them. The pupils may choose the two subjects further on, but only a rather small number of schools are able to offer such instructions in biology and geography in cause of the small number of pupils who choose these subjects.

Education in physics and chemistry is compulsory from the 7th grade to the 9th grade. Physics and chemistry are taught as one subject with 2 lessons a week. The pupils can choose physics/chemistry 2 lessons a week in the 10th grade.

The pupils can choose to attend a final test in physics/chemistry after the 9th grade. After the 10th grade they are allowed to attend the same final test or to attend a test at a more advanced level.

A need for changes in physics/chemistry education.

Less girls than boys attend the final tests and a school leaving certificate in physics/chemistry is a real demand to a long series of educations. Therefore the school subject physics/chemistry has achieved special attention in the equality debate in Denmark. This fact has made careers masters and teachers interested in girls' attitude to the subject and to the contents of the subject. At the same time, great attention has been given from the educational institutions and employers' associations, as they anticipate a lack of qualified young ones per youth class (1, 2).

The contents and placing has also been discussed between the teachers in the subject physics/chemistry and the girls' rejection of the subject is seen as a symptom that many pupils find the subject difficult, irrelevant, and boring, and that consequently the subject needs a reevaluation.

Official Measures.

In Denmark all this has formed the background for the work with a change of the contents and the placing of physics and chemistry in school.

The lower grades.

The ministry of Education has published theme booklet no. 3 on "Nature and Technique" as a suggestion to how experimental work within the subjects geography, biology, physics, and chemistry may form part of the education from nursery school class to the 6th grade (3). One of the reasons for letting the rather small children work experimentally with activities within physics and chemistry is - as mentioned in the booklet - to let the girls achieve experiences with the subjects before their puberty.

The upper grades.

A national curriculum committee for physics/chemistry was established in October -85 e.g. in order to change the subject in a way that made girls keep the interest in physics and technique.I myself have been a member of the committee as one of the two women members. Not until now - early in 1990 - the work with the new national curriculum has been finished, and the publication is now published after several years of contradicting work.

In the end the two women in the committee felt, that the curriculum and the guidance to a high degree has achieved a form that might inspire teachers to a content and a way of teaching that might become better for the girls. Later in the paper I have described in detail what in my opinion makes the curriculum "girlfriendly".

High school.

In October 1985 a committee for education in physics in high school (gymnasium) was formed as well. This committee wrote a report (4) which formed the basis for the new regulation for teaching in physics in high school and it became valid together with a high school reform in 1987. Both the report and the regulation suggestions to contents and recommendations of the form of education have taken place in the light of a wish to make the subject more attractive to the girls.

Development projects.

In Denmark, the Parliament has granted 400 million DKK to development projects within the primary school system. From 1988 and probably until 1992 a lot more development projects are going to take place in the primary schools than has previously been the case. The projects are to be seen as an introduction to general changes in the primary schools.
A reasonable amount of these project deals with introducing activities within physics and chemistry in the lower grades. The projects are mostly teacher initiated and a great part of the teachers has as one of the goals for the education that the girls have to be presented to the subjects, while they are still young.

In the debate about the girls and physics it has become a myth that "when the subject is introduced before the 7th grade, the girls become interested" - and during the coming years we shall get a possibility to prove it for the big amount of pupils.

Until now only a small amount of experimental and development work with classes has been carried out in Denmark - only three projects with financial support from the ministry - with activities within physics and chemistry, making one able to follow the development for a number of years (5, 6, 7, 8). I myself have had the opportunity to follow two of these projects as a candidate scholar at the Royal Danish School of Educational Studies, to try the thesis about introducing physics and chemistry at an early stage in a prolonged study of a small amount of pupils.

The Langhøj Project.

I myself started one of the projects as a teacher, before I started my research project (9). At my former school I participated as a teacher in physics/chemistry/other science subjects in an interdisciplinary project with physics and chemistry activities in the science education in an interdisciplinary cooperation with Danish. The project started from the 3rd grade, where the pupils had 4 lessons of science per week. In two of the lessons two teachers were present in the class, as the children's teacher in Danish (form-master) was the other teacher in the project. In this class we have started activities within physics and chemistry in connection with some of the subjects we had worked with in the class in other connections. An example is a subject about snow, ice, and water in connection with a special project about Greenland.

The pupils' questions and everyday experiences have also been the basis for investigations, e.g. we made some minor investigations of plastic, because the pupils wanted to know, what material marking rings were made of.

I have continued working with this class as part of my research project. The other teacher in physics/chemistry at the school took over my part as a science teacher in the class, and I have taken part in the project as participating observer. - This means that I take part in some of the planning of the education, I take part in some meetings about the pupils, I observe in some situations, but sometimes I also take over the part as a teacher. Furthermore I am once in a while together with the pupils in connection with other arrangements, and I often take part in the pupils' excursions.

The girls in this class take very actively part in technical discussions and bring up new ideas for the future work. They are generally brighter than the boys, because they both participate actively and in an interested way in experimental work, and at the same time work more seriously with describing and reporting about tests (7, 8). The class has reached the 6th grade in the school year 89/90.

"Mathematics, physics, data - and girls' attitudes" at Tofteskolen.

6th grade

Another part of my project has taken place in cooperation with Kirsten Gronemann, who at the same time of the beginning of the cooperation had a 6th grade, which since first grade had had physics activities in connection with the teaching in mathematics at Tofteskolen in Helsinge. The Experimental Board of the Danish Primary School had supported the project, which has been reported in "Mathematics, physics, data - and girls' attitudes" (6).

The first thing I made together with the class was a teaching course in chemistry. The teaching was built on some material that I had made in another connection.

At first, Kirsten and I went through the technical matters together. Then Kirsten was the teacher of the class, and I participated as an observer. However, the children also regarded me as a special kind of physics/chemistry teacher, who could be used as a consultant. Afterwards I participated in the evaluation of the course, and I got a number of papers and the pupils' test assignments after the course. In a postscript to "Physics, mathematics, data - and girls' attitudes" I made an evaluation of this course. I have been in the class since - on visits to follow the development and as a consultant to the class.

7th grade

The pupils are now in the 8th grade. The pupils start investigations and experiments in a far more qualified way than I was used to from other classes at the same level. They themselves plan to a great deal the direction of the investigations and were very preoccupied and interested. Especially the girls came a long way, as they worked more systematically with their registrations and notes than did the boys.

Learning about electricity.

In the 7th grade the class had a course in how electricity works which I want to describe here. Kirsten worked together with the other teachers in physics/chemistry at the 7th grade level about a mutual professional planning of the year, and it was the choice of this group that a course in the function of electricity was to be included. An area which is traditionally difficult, irrelevant and boring for girls.

The class has previously been occupied with electrical circuits, and both boys and girls - but mostly the girls - remembered this topic as "a bit difficult and a bit lengthy/boring". Therefore, Kirsten and I have discussed what was needed in order to catch the pupils' interest. The class chose to build model houses and install electricity in them. As a starting point Kirsten has been able to use educational material developed at the Royal Danish School of Educational Studies: "EL-7" (10), but her pupils insisted in their houses to be three-dimensional models, not only "diagram houses" in one plane.

A couple of the boys found it exciting - in itself - to have to learn something about electricity and to have to solder, but the girls did not get involved in the project until they were able to use their phantasy and imagination in connection with planning of the arrangement of the rooms, and first at that stage they found it exciting to start up a course in the function of electricity.

Evaluation of the course, Learning about electricity.

The pupils have now finished their project about electricity. The girls' and boys' houses have become very different. The girls have decorated the model houses with furniture, carpets, and lightning at the right places. They have attached great importance to making their houses look like reality in decoration more than they did on the technique. One of the houses built by the boys has also been equipped with furniture, pictures etc. It is built in Lego blocks, and the electrical installations are put in between the Lego blocks. - The other boys have built model houses, in which electrical circuits have been installed, e.g. are all switches placed on the outer side of the house, so that you have to light the light in the bathroom with a switch outside the house. They have had no particular imaginations as to the function of the rooms.

Generally, the girls find that the most exciting part of the educational course has been the planning and decoration of the houses, while a great part of the boys express that it was exciting to learn how to solder etc.

During the course I observed that both girls and boys worked in an interested and preoccupied way with making the electrical circuits.

In an essay written halfway during the course both girls and boys exclaime that it is exciting and interesting to work with the tools and the circuits. Both boys and girls tell in the evaluation that the work became boring, when something didn't work and they had to do an effort to find the errors.

Girls and boys had different ways of problem solving. The girls had the ambition to find and solve the errors, i.e. shortcircuits in a group work and they made a great effort to solve the problems at once. In the boys' groups either one or another disappeared from the work to look and to make fun in other groups. In some of the groups one of the boys took the responsibility to solve the errors.

The girls were more dependent on their "success" in the immediate educational situation than the boys are. The boys blame errors e.g. in the electrical circuits of the equipment. As an example two of the boys called on help several times and exclaimed that there were troubles with a noise generator in their circuit, but every time they themselves had made the electrical connection to the wrong poles.

The girls tell in the evaluation that the work became exiting again at the end of the course, when they were going to finish the houses with decoration etc.

Both boys and girls underline in the evaluation that it has been good that they themselves were allowed to plan, how their model houses were to look, and a couple of the girls underline that they have been glad to work with something that wasn't just like the others.

During the course the pupils worked with measurements and theoretical questions. The groups of girls mention that it had been a good experience to work with the theoretical questions.

In the final professional evaluation the girls did on an average get better marks than the boys.

Do the girls stay interested?

Will the girls' interest survive the troubles of puberty with the girl/woman role? In the experimental class at Tofteskolen it seems so. The pupils are - as mentioned - now in the 8th grade and have started the obligatory teaching in physics/chemistry. The way in which the class has worked with the matter in the 7th and 8th grade physics and chemistry lessons have been much more qualified than is the case in "normal" 7th and 8th grade classes.

A more active teaching with experiments will give both girls and boys a better teaching. But of course the girls' participation in the physics/chemistry teaching is dependent on the contents of the teaching, the time together in the class, whether there is "room" for them in the teaching - and so incredibly many other things, e.g. the collective expectations to the girls' role within themselves, in their surroundings, and in society.

Therefore, I am generally not so sure that the interest in physics and technique from the teaching in the lower grades is kept later on. Foreign experiences with "science teaching" in the lower grades have thus not shown that girls kept the interest later in the educational course.

An English investigation, exactly dealing with the change from the lower grades to the obligatory science teaching in the upper grades, seems to show that pupils, who have science in the lower grades, do not show a greater interest in science during the first year at "secondary school" than pupils, who have not had such lessons. However, it turns out that the teacher and the preparation of the teaching in the new classes has a decisive influence (11).

This means that changes in the teaching of physics and chemistry for the advanced pupils will be necessary, if a positive attitude to and interest in physics, chemistry, and technique is to be kept in the girls.

What is a "girl-friendly" curriculum in physics/chemistry?

A number of investigations both in Denmark and internationally have shown that girls to a higher degree than boys prefer to relate the matters in physics and chemistry to phenomena in the nature, or that they can be put into a personal or social relation. In other words, girls do to a higher degree than boys, need a reason for the subject, which lies beyond the internal reason for teaching in physics/chemistry (12, 9).

In the 7th grade class mentioned above it is characteristic that all the girls, as a reason for the importance of learning about physics/chemistry wrote something which is relevant for them right now, e.g. that it is important to learn about electricity in our houses, or about which chemicals are used in on housekeeping. Some of them wrote furthermore that maybe they were going to use it later in their education. - Not all the boys gave reasons, and some of them wrote that it was fun, In the "girl-friendly" suggestion to a curriculum emphasis is especially laid on the limitation of the professional content to be motivated with facts about what the subject was going to be used for. The curriculum committee had made a suggestion with five central areas of knowledge and skill:

- The methods and ways of consideration related to the subject
- Matters and phenomena around us
- The scientific world picture
- Life and environment
- Technology

Each area is introduced with a reason for it and a limitation of which part of the subject that belongs to the area.

The curriculum is not separated in classes within the obligatory course from 7th - 9th grade.

The curriculum has been written without going down into professional details; e.g. it is under life and environment mentioned that at least one example of a physical or chemical cycle in nature has to be dealt with, i.e. classes - depending on where they live - may learn about the cycle of nitrogen and nitrate pollution.

This means that teachers - and pupils - within the frame given in the curriculum may and have to plan professional details.

At the same time there is a possibility to make courses across subjects, e.g. one might imagine a teaching course where "the energy supply in your own environment" was enlightened both seen from a physical/chemical side of view and from a social-technical point of view.

My research work points at the fact that the feeling of having an influence on the teaching is of great importance to the girls' interest. The curriculum is written in a way that makes this possible - based on the arguments written for each main area.

And then all problems are solved?

When I, in connection with my research work, have had conversations with pupils in the upper grades, I have become amazed of how narrow their conception of the subjects has been. In a 10th grade class the girls were not able to imagine any matters within physics or chemistry that might be interesting, based on their previous experiences from the teaching in the subject in the grades 7th - 9th. Not until we together had had a discussion about a broader conception of the subject they were able to express wishes and suggestions to the teaching. Several of them have in an interview after the termination of the 10th grade mentioned that the fact that they themselves had got influence on the contents of the teaching, had been a contributing reason for them to like physics/chemistry in the

10th grade, and that they had managed well in the subject to the final test.

With this background I feel that an open and wide curriculum will be a step on the road towards an opening of the physics/chemistry subject for girls in the primary schools.

With this I don't mean that the teaching is to be made superficial or without professional content. On the contrary, it is my opinion that the professional immersion is to be qualified through the selection of material, in order to secure that teaching will deal with something that is relevant to the pupils, and with something they have a feeling of can be used, not "only" for the girls' sake, but for a better teaching in physics/chemistry. But even with the "girl-friendly" changes in the curriculum I will point out that it is only a necessary beginning of the changes that ought to take place in the teaching.

In my project classes the girls participate with at least as many and good contributions in common discussions as the boys do. The girls are to a high degree fluent speakers and show great interest.

Nevertheless, I see some general differences in girls' and boys' working methods and relations in cooperation and in their demands to the relevance of the subject dealt with in the education.

The girls have (too) great ambitions for their work. Girls are generally more careful in finishing their projects, i.e. to do what the teacher - in their opinion - expects. They keep putting demands to having to understand what they are doing, and that they have to be good at it - sometimes even before they have started the work. Both girls and boys like to do practical work, but the girls are better at following guidances and to make notes. The boys often start up tests without worrying about making the tedious work of reporting.

Girls do like to have some kind of self determination, but at the same time they have the need to get positive feed-back to be sure that they do well enough. Girls are dependant of the relations in the group cooperation and feel responsible for finishing the work. Boys are not so good at taking responsibility for themselves in relations of cooperation. They often expect the teacher or others in the group (often girls) to act as an outer authority. In the above mentioned classes where girls do physics - and like it - it is common that the pupils have some kind of self determination.

It is also common that in both classes efforts are made to make the pupils responsible for their own learning situation. The teachers in the two classes put at each individual level some specific demands to the pupils, and they are good at pointing out what the purpose is with the different parts of teaching.

There will be a need for the teachers to be aware of the differences between girls' and boys' behaviour in the classroom and their different learning style - and to try to cope with the diversities.

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WHY DO FEMALE STUDENTS TEND TO AVOID COMPUTER STUDIES?

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Abstract

210 students of Business and Natural Science subjects, many of whom were qualified to study computing, were given a questionnaire during their first year enrolment. The questionnaire concerned their choice of course and why they chose not to study computing. The results, both open ended and statistical, indicated that computing had a very bad image problem as a future career or subject to study. The greatest perceived problem was that students of both sexes, but particularly females, wished to work with humans, not machines, and that computing was perceived to involve sitting at a computer terminal most of the time. Females gave relatively slight importance to the prospect of male domination putting them off choosing computing. School computer experience was reported as often either minimal or non existent, particularly for females, or to have been sufficiently negative to put the students off computing.

Introduction

The number of female applicants to university in the U.K. intending to study computer studies has actually been declining at a time when government and industry are worried about skills shortages in computing. The annual statistics published by UCCA (e.g. UCCA, 1989) have also charted a reduction down to 11% of the proportion of home university entrants studying computer studies that are female. This situation has led to various special organisations and schemes coming into existence to address the question of the low female representation in computing, such as WIT (Women into Information Technology) and WIC (Women into Computing).

Delin (1988) and Watt (1989) describe day schools aimed at schoolgirls arising from these concerns. However, in spite of these initiatives, in many ways computer studies now shares the gender profile of engineering in the U.K., (UCCA, 1989), but it is not inevitable that technology must be a man's world, as shown by evidence from places as diverse as Norway (Hagtret and Undheim, 1988), Eastern Europe (Durndell, 1988) and Kuwait (Al-Methen and Wilkinson, 1988).

Recent research in the UK and USA has emphasised that girls tend to have less experience of computers and use computers less than boys (Breakwell, 1986, Linden et al, 1987, Durndell et al, 1987) and there is evidence that some girls are put off studying computing by the image of what computing involves and the rather negative perception of being surrounded by males (Durndell et al, 1990). However, at the same time research has indicated that attitudes towards computers are generally positive (Gardner et al, 1986, Breakwell et al, 1986) in that computers are seen as useful contributers to our societies development. Furthermore, female computer scientists do not seem to be negatively stereotyped (Siann et al, 1988). In the case of females these attitudes seem often to be combined with a 'we can, I can't' (Saunders, 1987) view about their own personal capacities in computing compared with females in general. In other words we (females) can, but I (personally) cannot. This can be linked to the possibility that females are more pragmatic than males in their approach to computers, that is that they may be relatively less interested in computers per se, but are happy to use them for a particular purpose. Finally, considerable disquiet is now being expressed about the introduction of computing into schools (e.g. Newton and Haslam, 1988) which does not seem to be attractive to girls (Kelly, 1985, Durndell et al, 1990). Schoolgirls are still tending to choose subjects which conform to a stereotyped female interest in living things and humans, subjects such as Biology and Business Studies (e.g. Kelly, 1989).

Much more still needs to be understood about why females are not choosing to study computing in the U.K.. Durndell et al (1990) reported on the reasons for choosing their course of 387 newly enrolled students (in 1987) on a wide variety of degree courses. It was decided to follow this up in 1988 by targetting courses that contained large numbers of females, who whilst qualified to studying computing chose instead to study either in Business areas or Natural Sciences (cf. UCCA, 1989). They could be asked specifically why they chose not to study computing (Kelly, 1988, Culley, 1988) and their answers should be of interest as they represent those students who could potentially be attracted most easily into computing.

It was hypothesised that potential female students of computing would be put off studying computing more than their male colleagues by a perception of a lack of human contact in computing, by a perception of an unfeminine image of computing and the prospect of harassment by males. (The possible importance of this last item became apparent from open ended remarks by subjects reported on by Durndell et al (1990). It was decided to investigate it more systematically here.) It was also hypothesised that females may be more likely to doubt their own capabilities in computing than the males would, and would take a more pragmatic approach to computers.

Method

The sample comprised 210 students enrolling for their first year at a Scottish Higher Education institution. They were chosen as having selected to study degree subjects which would provide: (a) reasonable numbers of both male (55) and female (68) business oriented students who would potentially be qualified to study computing (BA Business Studies and BSc Maths for Business) and (b) reasonable numbers of science oriented male (30) and female (57) students who might be qualified to study computing (BSc Applied Biology and BSc Ophthalmic Optics).

The students were presented with a questionnaire as part of their enrolment session. It was administered in a class group situation by a psychologist who was not to be one of their tutors. A promise of confidentiality was given and an assurance that this was a research exercise and that no information on an individual would be passed on to the course organiser. Filling in the questionnaire took about 15 minutes.

The questionnaire requested background information on age, sex and qualifications. Respondents were then asked a first open ended question - "why did you choose to study on this course?" and were requested to write in their answer. On a separate page a second open ended question was asked - "why did you choose not to study computing?". On a further separate page respondents were presented with a 5-point scale going from 1 - of no importance to me, through to 5 - very important to me. They were then asked how important to them were the following items in their decision not to study computing, and were presented with a list of items which they were asked to evaluate for themselves using the 5-point scale.

Results

(a) Open ended questions:

The main focus was on the answers to the second open ended question, "why did you choose not to study computing?" Apart from the common response that the student was not interested, the answers could be seen to reflect three main themes which to a large extent were produced by both sexes:

1. In the words of a male Business Studies student "computing needs a

new image". 17% of the students volunteered comments about their desire to work with humans rather than machines, and appeared to be put off by the image of sitting all day in front of a screen. For example, Business females commented "the thought of just punching a keyboard all day just would bore me", and "computing doesn't allow enough contact with people". Business males commented "didn't want to spend my life watching little green figures or a TV monitor" and "computing restricts you to working with machines rather than people". Applied Biology females commented "no satisfaction working with a man made brain, the human one is more interesting" and "did not want to be stuck behind a computer terminal and monitor for the rest of my life" and a male commented "no ambition to be a tool or machine operator".

2. Many respondents, including 42% of Business students, volunteered comments to the effect that computing was too specialised a subject with too narrow employment opportunities. They were happy to study computing as one small part of their studies, recognising its uses, but that was all.

3. The third theme was two pronged. On the one hand a surprisingly large number of respondents (8% of males as opposed to 36% of females) volunteered comments that they had had little or no contact with computers before coming to Higher Education and therefore were unlikely to choose to study computing. 46% of female Maths for Business students gave this response, indicating that maths and computing were clearly separate for them. On the other hand, 19% of respondents made negative comments about their contact with computing at school, mainly concerning how boring it was, and commented that this contact had helped to convince them not to study computing.

Statistical Results

Table (I) shows the average level of evaluation for the suggested items in student choice not to study computing, arranged in order from highest (most important) to lowest.

Table I: Average score of importance for suggested items in choice not to study computing

Item	Average score for the whole sample	't' test Male vs female	Average female score	Average male score
The subject matter would not be interesting	3.51	N.S.		
I am more interested in people than objects	3.43	p = .001	3.69	3.02
I don't mind using computers, but they are not an end in themselves to me	3.17	N.S.		
Studying computing removes you from contact with people	2.83	p = .005	3.05	2.50
I do not have the required abilities	2.63	N.S.		
I would have difficulty getting a job with a computer qualification	2.61	N.S.		
I am not qualified to study computing	2.56	p = .003	2.80	2.19
The prospect of being in nearly all male groups is offputting	1.82	p = .001	1.60	2.16
Video and computer games turned me off computing	1.69	N.S.		
Males can be hostile to females with abilities in computing	1.52	p = .005	1.66	1.30
Computing has a rather unfeminine image	1.34	p = .02	1.42	1.20
I was advised not to study computing	1.32	N.S.		

(N.S. = not significant)

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Discussion

The clearest result to come out of this study was that computing has a severe image problem in general, and that this is accentuated for females. Both open ended and statistical results confirmed that students of both sexes perceived the lack of human orientation or contact that they considered to be part of computing to be a very strong factor in their choices to avoid studying computing. They wanted contact with people, not machines, and in accordance with gender stereotyping females found this on average even more important than males (who still found it important however). The contradiction between the many negative remarks about computing made in this study with the generally positive attitudes to computers found in other studies (e.g. Gardner et al, 1986) could be interpreted as the difference between thinking computing is useful and advantageous for society as a whole, but is not something that the particular individual wishes to be very involved in (another version of 'we can, I can't'?). It was also notable that it was not primarily an unfeminine image that was the problem (cf Siann et al, 1988), but one of the perception of a lack of human contact, which of course does have gender overtones to it, in as much as females might be expected to value human contact more than males. There was some evidence for females, relative to males, doubting their own computing abilities, but both sexes treated this only as a moderately important factor in their choices. Both sexes were relatively pragmatic in that they gave considerable importance to the item 'I don't mind using computers, but they are not an end in themselves to me'.

The results in relation to perceptions of harassment of females in nearly all male computing groups were much weaker than previous work has hinted at (e.g. Durndell et al, 1990) and although gender differences did occur, the importance of these aspects was dwarfed by the non-human orientation issue.

The females with a very strong mathematical background are of particular interest, as the school link between maths and computing has been criticised (e.g. Lockheed, 1985, Collis, 1987) as being offputting for girls. However, these females on the whole did not extrapolate from their interest and ability in maths to computing, and a surprisingly large number of them reported virtually no contact with computers before coming to Higher Education. Whether they would become more interested in computing following computer contact on their course is an interesting question.

The practical implications of this study are relatively clear. At Higher Education level attempts to widen courses and combine computing with other disciplines should be supported, as this would combat the 'narrowness' and lack of human contact that is perceived to be part of computing. Many computer specialists and employers would no doubt argue that the stereotype of computing as not involving human contact is inaccurate, in which case course publicity should pay attention to this issue and try and counteract this image. Alternatively many feminists have developed a critique of the whole basis of science and technology (eg. Bleier, 1988, Bentley and Watts, 1987, Elliott et al, 1987). From this point of view the only strategy that would be acceptable would be a thorough reorganisation, both of the content of computer courses and of the way that they are taught and publicised.

The situation in schools continues to be rather distressing (cf Kelly, 1985, Durndell et al, 1990, Askew and Ross, 1988). The problem as revealed here is two edged. That such a large number of recent school leavers in 1988, particularly girls, can report little or no contact with computers implies either a lack of sufficient computer equipment in schools and/or a lack of organisation in letting all pupils use it. Conversely, the fact that so many recent school leavers who have had school computer contact found the experience negative and boring, is a cause for deep concern. Furthermore, this seems to be a problem which relates to boys as well as girls. This may well be linked to the non human orientation issue, and it could be that the type of problems and examples addressed in school computing need to be chosen with great awareness of this issue. Indeed this is one of the central arguments of the feminist case. However, in spite of the attention given to the problem, it seems that at present we are a long way from giving school students of both sexes a reasonable experience of computers and a long way from presenting the human face of computing that might be more appealing to a wider group of students.

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WOMEN IN CONSTRUCTION - COMPARATIVE SURVEY OF WOMEN AND MEN IN CONSTRUCTION, ENGINEERING AND BANKING AND FINANCE INDUSTRIES

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SUMMARY

This paper reports on some of the initial findings of a recent structured interview survey carried out in the second half of 1989 involving 20 participants school students, undergraduates and graduates. The aim of the research is to establish why there is very few women in the industry. The working hypotheses are concerned with image of the industry and knowledge people held of the industry. A construction industry employment model is put forward. Research is focused on building professionals. Findings are mainly based on an interim analysis of the school student responses augmented by initial observations on undergraduate and graduate responses. Tentative conclusions are drawn. There appears to be potential for improvement in education about and publicity of the construction industry.

THE SURVEY

Very few women are employed in the British construction industry sector. An analysis of 1971 and 1981 Census data using revised Warwick Occupational Categories and Social Accounting matrix industrial classifiacation of the Cambridge Growth Model shows that, in terms of vertical occupational

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segregation, 75% of the women employed in the industry carry out clerical or secretarial work compared with less than 2% of the men. In 1988 only 6% of the full time work force were women (1)

Only 8.1% of all applicants and 7.4% of admissions for degree courses in building in polytechnics were female in 1988. For universities the figures were 7.3% and 11.5% respectively (2,3). The figures for membership of construction industry professional bodies are worse: Royal Institute of Chartered Surveyors (Quantity Surveying Division) 3.2%, Institution of Civil Engineers, 2.0% and the Chartered Institute of Building, 1.0% (4). For the purposes of this research the graduate route to professional occupations was identified and the subject of building specifically focused upon.

In terms of actual occupation the term building professional is taken to be a construction manager, site manager, building consultant, contracts administrator, quantity surveyor, construction planner, estimator or similar with a degree or chartered status (eg; Member of the Chartered Institute of Building (MCIOB)). The construction industry is defined by Hillebrandt (5) according to the Standard Industrial Classification (6).

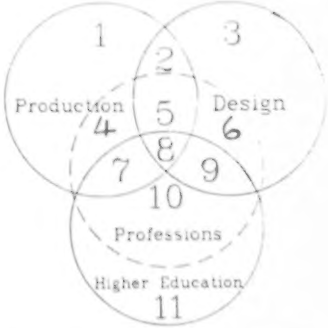

Figure 1: Construction Industry Employment Model

The model used to represent the occupations contained by the construction industry is shown in Figure 1. This is needed as the use of job titles such as those mentioned above is misleading; misleading when used in a cross-cultural context.

Space does not allow a full definition of all segments in the model (Figure 1). The occupations under investigation are defined in segments 4 and 5. In both segments actors are normally chartered members of a construction industry professional body. In the case of 4, carrying out primarily production responsibilities at site and/or in an office. Segment 5 includes responsibilities of design and production at site and/or in an office.

The aim of the research is to establish why there is only a few women occupied as building professionals in the British construction industry.

There are two main hypotheses:

1. The image of the construction industry militates against the entry of women;

2. Knowledge of the construction industry discourages the entry of women.

The pilot survey to which this paper refers was carried out in the latter half of 1989. It forms part of the above defined research project. Table 1 shows the sample frame and sizes for both the pilot survey and planned questionnaire survey. Detailed methodological issues are not discussed here. The research design takes account of current debate on the subject of gender research (7,8,9,10,11,12).

The construction industry is compared with (a) a similar comparator - the engineering industry, and (b) a dissimilar comparator - the banking and finance industry.

There are three groups or levels; two in the home phase and one in the market phase. These phases are similar to those of human capital theory (13).

Table 1: Sample Frame

Phase	Group	Construction		Engineering		Banking	
Home	School student	2 male (25m)	1 female (25f)	1m (25m)	1f (25f)	1m (25m)	1f (25f)
	Under-graduate	2m (25m)	1f (25f)	1m (25m)	1f (25f)	1m (25m)	1f (25f)
Market	Graduate in Industry	1m (25m)	1f (25f)	1m (25m)	1f (25f)	1m (25m)	1f (25f)
	Pilot Main		8 (150)		6 (150)		6 (150)

Note: Structured interview pilot survey numbers shown # thus
Main questionnaire survey numbers shown (#) thus.

Participants were randomly selected in equal proportions male and female. The allocation of school students to industries in Table 1 is notional. They were sampled from a large sixth form college (16-18 years of age studying for A levels) in the middle of England. They were all studying 3 or 4 A level subjects. Their ages ranged between 16 and 18 years.

Undergraduates were sourced from a London Polytechnic from sandwich courses in building, mechanical engineering and business studies. Their mean age was 23.3 years, range 21 to 32 years.Graduates in building, mechanical engineering and economics. Their mean age was 24.2 years, range 22 to 27.

Audio recorded structured interviews were carried out over an approximately 40 minute period. Each interview was designed specifically for each cell in the sample. Questions asked related to the two main hypotheses associated with the image of the construction industry and peoples knowledge of it.

SOME INITIAL FINDINGS

Interim analysis was carried out on the school students interviewed. What follows is based on a small part of that analysis (18) augmented by initial observations on data from the undergraduate and graduate participants.

All school students were vague when attempting to define the construction industry. They had very little accurate knowledge of the industry's professions. Undergraduates said that as school students they knew very little about the construction industry or any other industry. Except for those working in the construction industry graduates had only a superficial knowledge. There did not appear to be any gender difference in terms of knowledge held.

Female school students knew about various initiatives aimed at encouraging women to become engineers such as Women Into Science and Engineering (WISE) (14). They saw financial rewards as 'quite good'. Professional occupations were seen as much less problematic for women than manual trades. Males appeared to know a little about architectural and engineering possibilities. One male thought that women were; 'sought after in construction for public relations purposes'. He felt architectural work was; 'related to the female side of the mind'. Males did not think manual work appropriate for women because of problems they would face at work. Female school students said that males had practical interests which led them to become workers in the construction industry. Males saw no problems for males if they were 'practical' and 'science minded'. The female undergraduate building student said that she would not encourage a daughter to work in the industry if it was to be a site based career. Her male counterpart said that he would encourage a son more than a daughter. Engineering and business studies undergraduates were non-committal.

Participants were asked; What do you think about women pursuing a managerial career in the construction industry? One male school student said that women were:'more considerate than men' and that this would improve management. There was a general view by all school students that women were equally capable. Female responses indicated anxiety about the male domination and male orientation of the construction industry. All females saw promotion prospects as a problem for women. One said: 'You've got to be sure of yourself'. These views appear to be similarly held by both undergraduates and graduates interviwed.

Questions were asked about perceived aptitudes and personality traits of those best suited for professional careers in the construction industry. Both male and female school students, undergraduates and graduates cited team working as an important attribute along with the capacity for hard work. The female building undergraduate said that women on site were: 'branded as hard nosed bitches'. All but one graduate saw communication skills as important. The female banking and finance graduate thought that the construction industry was not a 'people industry'. The female engineering graduate thought that an ability to cope with chaos and panic situations was essential. She had first hand knowledge of the industry when working as a specialist subcontractor.

Certain participants had had personal contact with those in the industry. This appeared to influence their responses. One female school student said that all those in the industry were outgoing and lively; enjoying a challenge. This opinion is confirmed by responses from undergraduates and graduates interviewed in this sample and in previous interviews. One male school student saw the construction industry as: 'less refined than office workers who were university educated'.

Participants were asked to give one word that they felt would characterise the construction industry. These are tabulated in table 2.

Table 2: Words characterising the construction industry

Group/Sex	Construction	Engineering	Banking/Finance
School Students			
MALE	necessary & manual)		
	manual,risky,)		
	practical & manual)		
FEMALE	useful & destructive)	DISTRIBUTED OVER ALL INDUSTRIES	
	technology,)		
	interesting & hardwork)		
	Physical)		
Undergraduates			
MALE	inefficient	hooligans	there
FEMALE	powerful/ masculine	big	building
Graduates			
MALE	dinosaur	interesting	aggressive
FEMALE	dynamic	chaos	mediocre

Most of these words are quite graphic. One could image a caricature of a building site displaying many of these images. It is interesting to note that male school students see the industry as manual. Only one female student characterised the industry as 'physical'. This manual dimension is lacking in undergraduate and graduate responses.

CONCLUSIONS

It appears from these brief interim findings that the construction industry has a poor image. School students appear to have very little factual knowledge about the construction industry, its professions or degree courses available. Females seem to rate the creative opportunities of the industry higher than do males (cf 17) which may explain the interest in the architectural side but nothing was really known about that aspect.

A tentative conclusion is that image has some effect on the level of female employment in the construction industry. What is important perhaps is the level of knowledge held by girls, and boys for that matter. Fathers may play a key role in the case of female students (cf 15,16).

Results obtained to date generally coincide with previous research. The evidence so far suggests that (a) the relative images held of the industry by females and males should be investigated further,and (b) there is potential for increased publicity and education about the construction industry and its professional occupations (18).

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WOMEN AND MEN IN ENGINEERING EDUCATION - DIFFERENT APPROACHES ?

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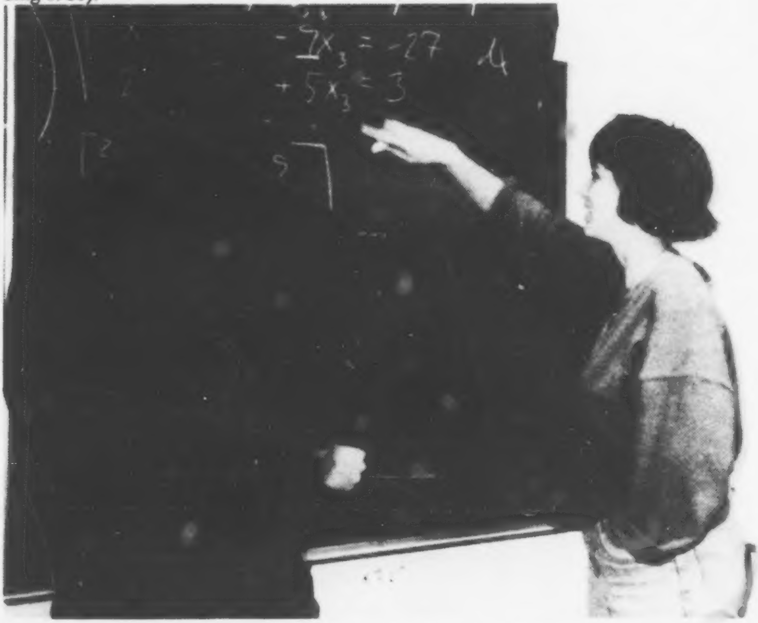
Introduction

Do women have another approach to technology than their male colleagues? This question has been raised several times in different GASAT research projects. It is a radical feminist necessity to get a positive answer, otherwise recruitment of women into technology and science seems "only" to increase the number of women and not to change technology and science into a more human development. (Harding 1986).



As a part of my research project, "Women's Approach towards Engineering"[1] (Kolmos 1986-1989), which I finished in 1989, I have made an empirical investigation ("Gender and Knowledge in Engineering Education" or "Køn og viden i ingeniøruddannelsen", Kolmos 1989.a). One of the questions I have asked in this empirical investigation is whether women bring other values into engineering education.

In this paper I will present some of the results from this investigation. Furthermore, I want to make some methodical reservations related to the framework of my investigation. According to my experience we are not critical of the results presented at GASAT conferences. The only way we can be critical and constructive is by discussing the methodical framework - so why not start by being self-critical.

The agenda will be as follows:

1. Results from the empirical investigation: "Gender and Knowledge in Engineering Education" (Kolmos 1989).
2. Critical remarks to the methodical framework.

1. RESULTS FROM THE EMPIRICAL INVESTIGATION: "GENDER AND KNOWLEDGE IN ENGINEERING EDUCATION".

This survey was done from 1985-1987 at the University of Aalborg in Denmark. I have used both interviews and questionaries. In this paper I will primarily refer to the questionaries comprising 162 students with a response of 83% and an equal number of women and men. The students were in their 3rd and 4th study year and they represent the gender distribution on the various engineering sides[2] at the University of Aalborg.

1.1 The choice of an engineering education

Choice of education is an indicator of the attitude towards technology. An increasing number of women have entered engineering - about 20% are today women.

My survey shows that *family background has an important influence on choice of education*, and it is a fact (Billing and Bruvik Hansen 1984, Kvande 1984) that knowledge of technology increases the choice of technology and science. 16% of the women and 11% of the men had a father who had an engineering education.

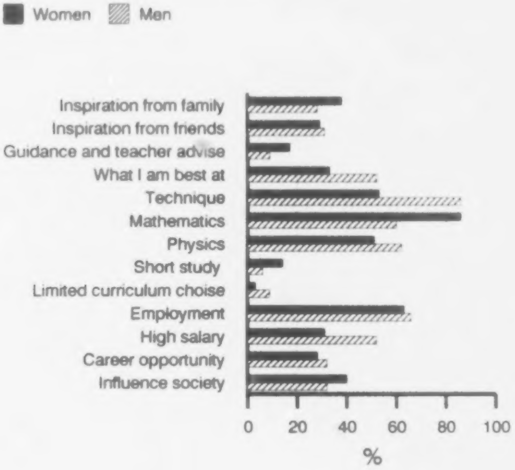
The *engineering education mainly recruits from the mathematical physical side of the "gymnasium."* About 50% women and 70% men come from this side. On the other hand, a larger part of women than men come from the mathematical biological side of the "gymnasium." In some sense you might say that women have a more non-traditional choice of engineering education than their male colleagues.

The different *sides in the "gymnasium" determine the choice of the engineering side*[3], as a large part of women coming from the mathematical biological side in the "gymnasium" choose environment or planning.

It thus appears that the ealier choice of educations is reflected not only in the choice of technology and science, but also in the sides women choose of technology and science in higher education.

Below you can see the respondents' own answers of why they have entered the engineering education:

Fig. 1: *The "yes" answers to the question: Which of the following motives have influenced on your choice of an engineering education?*



It is remarkable that more than 80% of the men reply that "interest in technology" was important, and "only" 52% of the women find that motive important.

You find the opposite picture if you look at mathematics. More than 80% of the women find mathematics important whereas "only" 60% of the men find it important.

Therefore, I am tempted to say that the *educational system plays a much more important role for women's choice of technology and science than for men's choice.* Technical interest is the most important motive for men's choice of engineering - and they mainly obtain their technical knowledge outside school.

This is no new conclusion as we have known for many years that women have entered the labour market through the educational system.

However, in Denmark the Minister of Education forgot this fact when he changed the structures of the Danish "gymnasium". Until 1988 we had rather strict sides between which you could choose. Now we have a system of nearly free choice which means that the students may choose almost whatever subject they want.

We are still awaiting the results of this educational change. However, we fear that the proportion of women choosing physics will decrease. Meanwhile, the science and engineering studies at university level increase the qualification demands towards a higher level in physics, mathematics, and chemistry.

It shall be very interesting to investigate this development and especially to find out to which extent educational structures influence on the gender choice of education.

The conclusion of the entering motives in relation to men's and women's attitudes towards technology is that a larger part of the women compared with the men choose environment and planning, and that they have a background in biology from the "gymnasium".

1.2 The Approach to the Contents of the Education

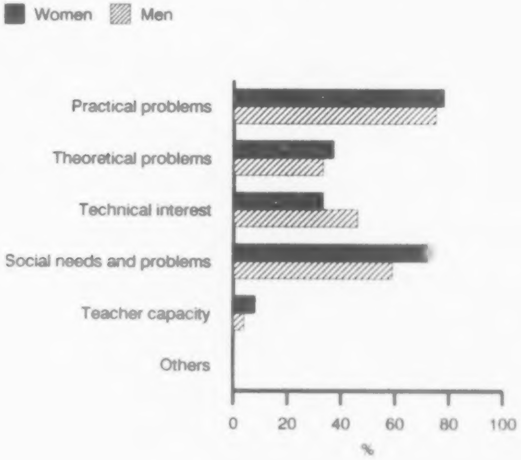
I have not found any statistically significant difference between female and male approach to the contents of the education, as regards neither the pedagogical nor the study-related aspect. However, there is a tendency that a larger number of women than men give priority to project work and technology assessment. I must stress that it is a tendency, only, which is not significant in relation to the overall investigation.

The engineering education at the University of Aalborg contains project work and group work during the whole course. The students work together in groups of 3-8 students (the number depends on ressources and which term). The students start their project by preparing a problem formulation upon which they are expected to analyse and solve this problem. Half the time the students work in their groups, using the remaining time for lectures and course work.

A larger percentage of women than men want more time for project work, and women as well as men argue that learning is much more effective if you "create your own learning" instead of "falling asleep" at lectures or courses.

There is almost no difference in opinion between men and women as regards the best starting point for the project problem.

Fig. 2: *Answer to the question: To which of the following do you attach most importance? (Possibility for more answers)*



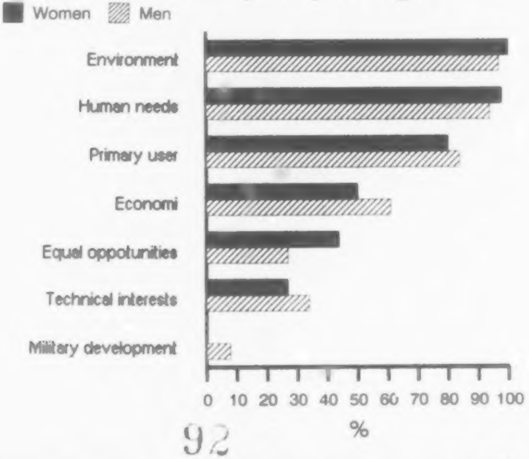
As appears, the majority of answers state practical problems and problems related to needs in society. A small percentage give priority to theoretical and technical problems.

Other questions in this survey show that *both men and women want more practical work - training outside the university, laboratory work, and contact to enterprises related to their specialization.* Again, there is a tendency that a larger percentage of women (80%) than men (64%) want training.

During the last 15 years the contents of the engineering education has become more theoretical, and at the same time a large percentage of students has entered engineering without any knowledge of what engineering is or could be. It is not only women who "lack" the tacit body knowledge from playing with technical toys. A large number of men "lack" this knowledge, too. It is no longer the skilled worker who becomes an engineer. However, engineering still needs experience- and experience comes from the practical work. Your own experience is an important part of the qualifications in order to to apply knowledge (Staudenmaier 1985).

The final figure in this paper concerns the direct approach to technology. I have asked the students what in their opinion should determine the development of technology.

Fig. 3: *Answers to the question: Which of the following considerations ought to determine the development of technology?*



There is no difference between women's and men's approach to technology according to this figure. It is remarkable that human considerations and environment are regarded the main motives for technological development. Unfortunately, one thing is saying what people ought to do, another is practical life - and there may be a difference between being a student and a graduate at work. However, there is hope.

1.3 Conclusion of the empirical survey

In this paper I have only presented parts of the survey. Supplementally, the survey shows that both women and men want technique and technology assessment in their education. Such wish puts women in a dilemma because myths of female engineering students still exist. If women prepare only the technical parts of a project, they may hear that this is not what female engineering students usually do. If they prepare only the technology assessment part of the project, they may be suspected of not having any technical qualifications. However, with a growing number of women in engineering such myths are dying.

Besides, a larger number of women than men find the working pressure at the engineering education to be hard, although the women spend only one more hour per week on their studies than the men (women 53 hours, men 52 hours per week).

As regards my question early in this paper (whether women have another approach to technology than men), this survey shows that the engineering student's approach to technology -interpreted by choice of engineering and approach to study contents both as regards pedagogy and study subjects - does not have any significant gender aspects. However, there is a tendency for women in engineering educations to place more value on aspects of technology assessment and especially environment in comparison with men.

However, women and men choose different speciality subjects in engineering. So they act with a significant aspect of gender.

Ambigous conclusions raise a number of questions. E.g.
Is this investigation not valid?
Is the discrepancy between approaching and acting a part of a strategy - or is it just life?

2. CRITICAL REMARKS TO THE METHODICAL FRAMEWORK

As the final part of this paper I will in short discuss four aspects of my methodical framework. These aspects are worth discussing not only in relation to my own research work, but they are general questions, too.

Actors and structures

Is it reasonable to ask the question whether women in higher education have a different approach to technology than their male colleagues? Focusing on the women and the men in engineering is focusing on the actors. This may mean that strategies for change are built on the actor's activity.

Why should womens' approach be different from mens' when they are working on the same issues, learning the same things? In other words, they are subject to the same structure - the same knowledge.

Therefore, it is not sufficient to focus on the actors, the structures are important as well. There has been a trend during the last 5 years (Harding 1985) to emphasize the structures. I disagree to that by maintaining that we must deal with both aspects. Knowledge becomes identity - identity becomes knowledge.

Gender is a structure, too. However, the crucial point is when does gender as a structure become more important for actors' identity than does engineering as a structure?

Students and graduates

According to the question above I will maintain that gender structures influence on the lives of graduates more than on the lives of students, because as regards graduates age encourages the reproduction structures in addition to the carreer structures.

My investigation concerns students and it does not include graduate women engineers.

Institutions

The institutional level is important - even if it is a traditional engineering education you will find a lot of important differences in the practice of education. Aalborg University has a pedagogical structure with small groups, problem solving, project work which is of great importance to the cognition of engineering science. Therefore, the validity of this survey is restricted by the level of institutions and only a comparison between institutions solve this problem.

Self-understanding and acting

During the last 15 years many research projects have been using both quantitative and qualitative methods. E.g. quantitative methods by using questionairies and qualitative methods by interviews. Using both methods gives a much deeper research result.

However, both methods tend to catch the self-understanding part to the disregard of the acting part. As regards the question of discrepancy between attitude and and acting, the only way to investigate this question is by catching both the acting and the self-understanding part of reality.

Concluding remarks

By these critical remarks I hope the conlusion of my empirical investigation has been placed in a wider context. I do not think that these remarks turn my conclusion upside down, but that they are emphasizing that the validity of my conclusions is restricted by the method I have used.

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Notes

1. Engineering education means Master of Science level.

2. At the University of Aalborg we have 5 main engineering sides:
   A) Planning and Environment,
   B) Buildings (civil engineering),
   C) Production,
   D) Electronics,
   E) Energy (power)

   Out of 100% women and 100% men entering the engineering education, the distribution is as follows:

		Women	*Men*
Planning and Environment	:	38%	15%
Building	:	15%	10%
Production	:	11%	22%
Electronics	:	8%	32%
Energy	:	6%	10%
Other education	:	19%	12%

3. At the University of Aalborg students choose the engineering slide during the first year of education. The first year is a common foundation year (basic year) to alle science and engineering educations.

SEX DIFFERENCES IN RESPONSES TO THE STUDY ENVIRONMENT OF A TECHNOLOGICAL UNIVERSITY

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SUMMARY

A group of female and male senior students of the Eindhoven University of Technology in the Netherlands were interviewed about experiences and
behaviour in relation to the study environment. It was found that satisfaction with curriculum and study progress is high and that women and men only showed little differences on this factor. The most interesting result concerns differences between sexes in type and frequency of social behaviour.

INTRODUCTION

This research is focused on the perception of a technical study and on behaviour in relation to the study and its environment.
The concept 'study environment' is defined as anything on a technological university that relates to curriculum and study circumstances in general.

The question is whether there can be observed systematical differences in perception and behaviour between female and male senior students.
More specifically we want to explore those aspects of study and study environment that make it harder for female students to survive in a male dominated technical environment.
Earlier research indicated that some aspects are more important than others. This concerns especially the following aspects: family background (van Vonderen en Dijkstra, 1987), faculty atmosphere (Lodahl and Gordon, 1972; Hartnett, 1981), study progress (Verwaijen-Leijh, 1985), evaluation of curriculum (Geensen, 1972), social contacts and identification with other students and with teachers (Everts en van Oost, 1985; Kirejczyk, 1987).

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Recently there is a slight increase of women choosing a technical education.
Nevertheless, in various departments, female and male students have not chosen in equal proportion. Apparently some faculties are more attractive to women than others.
Earlier research concerning the distribution of female and male students over the faculties demonstrated that in the Eindhoven University of Technology three types of departments can be distinguished (Overdijk, 1988). First of all there are faculties that have a tradition of a relatively high percentage of female students (for example the Faculties of Architecture and Chemistry). Secondly there are departments which showed a considerable growth of females within a few years (especially the Faculty of Industrial Engineering). Finally there is a group of departments which traditionally and actually attracts very few women (for instance Electrical and Mechanical Engineering and Physics).

Because of the reasons mentioned above we formed our group of subjects out of students of the following departments: Architecture, Industrial Engineering and a combination of the 'exact sciences': Electrical and Mechanical Engineering and Physics. With this combination a sufficient number of female subjects was obtained.
Senior students who had passed their propaedeutical examination (a comparitive examination after one year of study) were selected as respondents. These students have taken an important obstacle on their way to the engineer's degree. We expect these students to have progressed in identification with a technical profession.

METHOD OF THE STUDY

selection
One hunderd and twenty students were randomly chosen from the population of the faculties mentioned above. After an invitation by letter 77 students participated in the study.

	Architecture	Industrial Eng	Exact Sciences	Total
women	11	11	20	42
men	12	8	15	35
total	23 (30%)	19 (25%)	35 (45%)	77

Table 1, sex and faculty of the respondents

The exact number of female and male students of the Faculties of Electrical and Mechanical Engineering and Physics are 4, 7, 9 and 4, 5, 6 respectively.

conduct of the interviews

On the basis of a structered questionnaire we interviewed each participant during one hour to one hour and a half. As a start some introductional questions about background and study progress were asked. In the following part of the interview questions were asked concerning the study environment.

First we asked about the general impression of the curriculum. Among this we understand components like methods and difficulty of teaching, satisfaction with study choice and motivation. Then we asked questions concerning elements of the built environment, like the impression of the atmosphere of the buildings the students use. Within the framework of this paper, however, it is not necessary to go further on this subject.

The third aspect is related to the interaction with other students and implicates questions about characteristics and intensity of social contacts.

Finally we requested about the relationships with teachers.

At the close of the interview we informed about some general aspects concerning the satisfaction with student life.

analysis

The data of the 77 interviews are analysed for differences between sexes and departments by applying t tests and chi-2 tests. Because we were interested in differences between departments with a relatively high and a relatively low percentage of female students, sometimes we compared data of students in Architecture and Industrial Engineering (A&IE) on the one hand with the Exact Sciences (ExSc) on the other hand.

Because this study is exploratory in character, significance values have only been used to select promising relationships.

In the following description the most interesting data are shown.

RESULTS

background

Some questions in the questionnaire dealt with family background of the respondents like composition of the family and education and profession of the parents.

We found that female students compared to male students have strikingly more often a father with a technical profession ($p = .03$); two female subjects even have both a mother and a father with a technical education.

Answering the question whether their family is (much) interested in technology, significantly more women affirmed this (p=.0001).

Three quarters of the students live in a students house, it attracts the attention that relatively more females live exclusively with other students of the University of Technology (this concerns 12 of the 32 women and 5 of the 26 men living in a students house).

perception of study and curriculum

In this part of the research we asked about the experience and appraisal of both the study in general and the curriculum.

The study in general was investigated by questions about satisfaction and pleasure in the faculty chosen and in the technical university as an institution, and by measuring the extent to which the study among other things is experienced as important, easy and interesting.

Questions about the curriculum incorporate things like distinctness and difficulty of the programme, satisfaction about study accompaniment, preferences for certain methods of teaching and suggestions about improvement of the programme.

In both the perception of study in general and of the curriculum we found little differences between the sexes.

Although the overall satisfaction with choice of faculty and student life is high, the female students in general appear to be a little bit less content about their choice of faculty and a little bit more content about student life (these differences are small, systematic but not significant). Answering the question whether their motivation about choice of faculty has changed, many more women then men confirm this (p=.004).

On the other hand we found differences between students of various faculties.

Students in the exact sciences experience their study as more difficult than students of both other faculties (regarding the first year of study: p=.0001 and regarding the study at the moment of the interview: p=.08).

Most students experience their study progress in general as reasonably satisfactory, on a scale with 5=very satisfied the average is 3.8. The exact students are significantly less satisfied, the mean is 3.5 (p=.03). Moverover, experienced pleasure in choice of faculty of exact students is less than of other students (p=.005).

	women	men	A&IE	ExSc
not interesting vs. interesting	5.9	6.0	6.2	5.6
difficult vs. easy	3.8	4.0	4.7	2.9
frustrating vs. not frustrating	5.2	5.0	5.6	5.0

Table 2, mean scores of students answering quesions about meaning of study

The students were asked to judge on a seven-point-scale the statements about meaning of study to them; the higher the score, the more that study is percieved as interesting, easy and not frustrating. Again the differences we found between students of the various faculties were significant (the p-values are: .08, .0001 and .08 respectively).

perception of interactions

This aspect of the research is operationalized by questions about satisfaction with and character of contacts with students and teachers in the first year of study and at the moment of the interview. More specifically we asked about the preference for a larger number of female students and teachers in the faculty. The final questions referred to some general social aspects of being a student.

Also in relation to this subject the sex differences we found were rather minor. Yet, the differences concerning the interactions with teachers are rather serious.

At the moment of the interview the female students were less positive about the possibility to make sufficient contact with other students (p=.06).

The question if they would prefer a larger number of female students attending their faculty, is answered more enthousiastically by the male than the female students (p=.13). (Those who would like this very much are mainly exact students.)

Significantly more female students appear to have the experience that teachers do not take them seriously (p=.02). Half the respondents tell they never experienced this, one quarter dealt with it one or two times, and 21% repeatedly.

Asked if they knew other students with the same experience, female students more often affirm this (p=.01).

Again we found differences between students of the various faculties.

Like the women mentioned above, exact students are less satisfied about the possibility of making enough contacts (p=.03).

We submitted the subjects a number of statements concerning relationships with students and teachers of their faculty and asked for more or less affirmation. Exact students always were less positive then students of both other faculties. Significant differences between the students of the participating faculties were found on the following statements: 'I feel at ease in this faculty' (p=.02); 'I feel one with the students of my group' (p=.04); 'Other students leave you to yourself' (p=.06).

behaviour in relation to the study

The behaviour of the respondents was mapped by inquiring after the number of hours a week spent in the faculty building, attending lectures, instructions and practice seminars and the extent these hours are related to compulsory or free choice aspects of the curriculum. We also looked where and with whom intermissions were spent. At the same time we asked about study behaviour, like regularity of studying and to what extent this takes place alone or together with others.

We found some differences between the sexes concerning the time spent with some aspects of the curriculum. The time women spend in attending lectures is 8.5 hours a week, men spend 7.3 hours. Moreover, in attending instructions and practice seminars the females spend 6.6. hours and the males 4.6 (p=.009).

More then half of the students very often spends the lunch break in the building of the faculty. Regularly, half of the subjects goes home and this concerns obviously less females (p=.004).

The differences between faculties we found could be related to the perception of study difficulty. After one year of studying, half of our group of subjects passed their propaedeutical exam. It turned out that especially architecture students were relatively quick (p=.008).

We also asked whether the students had enough time left besides their study for hobbies or other occupations. Especially students of the Faculty of Industrial Engineering said they had enough time left, and many exact students sometimes lacked enough time (p=.06).

behaviour in relation to interactions

Questions about behaviour in relation to interactions with other students are about frequency of contacts with (female) students, with befriended students and with friends outside of the university, but also about places where students and friends usually meet.

Besides we asked respondents whether they had a personal contact with some teachers in particular and if they ever felt inhibited to ask a question during lectures, instructions or practice seminars, whether they knew teachers that had contacted them for formal or informal reasons and, the opposite, whether the students had contacted certain teachers.

We asked the respondents to name the percentage of their friends that is student at the University of Technology. The female students gave a significantly higher percentage, namely 65 as compared to 50 of the men (p=.03).

The average contact with friends is once every ten days. The average frequency of contacts with befriended students is once every three or four days. It turns out that exact students have significantly less contacts than the others with befriended students, namely only once a week ($p=.02$).
Asked for places where friends are met, we found that female respondents have strikingly less contacts in their former place of living or at their parents' home ($p=.000$).

Half of the group of subjects appears to have no personal relationship with any particular teacher, 14% mentions one person and 29% knows several teachers in a more personal way.

inhibited during	women	men	total
lectures	27	16	43 (56%)
instructions and seminars	5	6	11 (14%)
outside lectures	3	1	4 (5%)

Table 3, answers to: 'Do you ever feel inhibited in asking questions?'

As the table shows, more female students feel inhibited asking questions during lectures ($p=.10$). We found hardly any differences between students of the various faculties.

factor analysis

Factor analysis was applied on the data. The results gave us no reason to change the preceeding conclusions. On the contrary, they confirm our earlier findings. Sex is hardly included in the variables that constitute perception of the study environment. On the the other hand, sex helps to explain differences we found regarding behaviour in relation to study and interactions.
The faculty is mainly an explaining variable referring to the differences in perception we found.

DISCUSSION

This study was conducted with senior students, both female and male, of various faculties of a technical university. Generally satisfaction with curriculum, study progress and student life is high and little differences between sexes have been found.

Several differences were established between departments in response to the questions, these were mostly independent of sex. Participation of women in a faculty seems to depend on the image of exactness the particular faculty has. Apparently both females and males adjust adequately to what may be called the faculty atmosphere.

Major results in this study indicated that the most important differences between female and male students concern beahvioural aspects, that is type, frequency and place of social contact. For instance females more often live together with other technical students, they count more students among their friends, and women, more than men, stay in the city where the university is located. Contact with faculty members frequently ensues inhibitions and frustrations with female respondents.

Perhaps these results may be explained by postulating that female students, compared to males, build a network of social relationships that gives the personal safety necessary for maintaining motivation and adequate study behaviour in a male dominated technical environment.

This hypothesis will be tested in the next study.

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IN-SERVICE TRAINING ON GUIDANCE AND COUNSELLING FOR NON-TRADITIONAL CAREERS AND ITS POSSIBILITIES FOR INTERNATIONAL TRANSFER

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SUMMARY

The development of an in-service training course, consisting of a series of modules, is described. The modules deal with guidance and counselling for non-traditional careers, and are written for counsellors and science teachers.

The development of these modules is used as a case study in order to investigate whether materials developed in one country can be adopted and translated in another country.

It is concluded that issues like curriculum can easily be transfered. Guidance and counselling however are more suited for national use.

Conferences like the GASAT conference allow international exchange of information. Solutions found by some may help solving problems elsewhere. The low participation of women in science and technology education is a problem occurring at least in all Anglo-saxon and Nordic countries in Europe.

Many research data are used across frontiers. The question we would like to discuss is whether experiences can be exchanged, which experiences and under what conditions. By 'exchange' we think of: using in one country (eventually in translation) what has been produced in another country.

Exchange, translation or adaptation of materials is nothing new. International editors frequently do it. But they are never explicit on the method: what can be exchanged , and what not. And why. The educational literature is very silent on this subject. If there is any knowledge on the subject, it is accumulated in persons, by experience, or it can be found in files of editors, but they do not publish their data.

We will analyse this question through the case study of the development of modules for in-service training of secondary teachers on equal opportunities.

We start from an overall international framework, and then go into the detail of an elaboration of one or more elements of a national project. From there we will examine whether it is possible to go back to the framework, bringing in elements with an international dimension.

International context

The Standing Working Group of the Association for Teacher Education in Europe (ATEE) on equal opportunities in teacher education presented in 1987 to the Commission of the European Communities (EC) the "Curriculum framework for teacher education" (Arnesen and Ni Charthaigh, 1987).

The framework contains a series of suggestions for modules on gender issues and school structure. It also indicates different methods for including those modules. Thus a thematic approach can be used, but the issues can also be integrated in disciplines such as the history of education, the philosophy, the psychology or the sociology of education, and in curriculum theory.

The EC Working group on equal opportunities for girls and boys in education has adopted the framework as a basis for an action research programme on equal opportunities and teacher education, the TENET programme. The programme has started in september 1988, with ten EC countries participating.

The project briefly described here is one of the (six) Dutch projects. The topic of the project is "Training teachers for guidance and counselling of young women into non-traditional areas" and its purpose is to develop a series of modules for the in-service training of counsellors and science teachers in order to improve their counselling of young women into non traditional areas (science and technology).

This paper will not deal with the construction of the course itself, but rather with the contextual factors of the project: why a choice for modules and why these target groups. After description of the mainly national context.

it will be examined whether the international context will allow international use of the developed material.

Previous experience with in-service training

The modules are designed for in-service courses. In-service education is offered by teacher training institutes and universities to teachers in primary and secondary education (This paper concentrates on secondary education). Courses are practically free of charge for the individual teacher. Teachers generally follow them in their 'spare' time. The courses are not compulsory. Their length varies from one session to several months (mostly one session of 3 to 4 hours per week).

Equal opportunities as official policy of the Ministry of Education and Science started in 1979. In successive years a series of measures at different levels of education was initiated, among which the development of several in-service courses on equal opportunities.

From 1981 to 1985 these courses have been taught at four (out of ten) secondary teacher training institutes and in some universities.

Topics dealt with:

- interaction in the classroom;
- teacher behaviour and student behaviour;
- socialisation of girls and boys;
- socialisation of teachers themselves;
- sex stereotypes in textbooks;
- dealing with resistance within the school;
- choice of didactic methods;
- subject choice and career choice of boys and girls (Kleve a.o., 1985).

The number of subscriptions to the course has remained rather low. These courses, entirely dealing with equal opportunities, have stopped after 84-85.

An evaluation of the courses has shown a number of causes for the low interest. Among them:

- Since in-service education is not compulsory, a substantial percentage of teachers never attends any course.
- Teachers attend courses in order to find solutions for problems. Unequal opportunities is not perceived as a problem.
- Information on the courses stops at the management level and does not reach the teachers.
- And, in general, there were, especially in the early years, many resistances in the school against signs of feminism.

The courses were general enough to host teachers of all kinds of subjects.

There has been one course especially designed for physics teachers. This was done by the MENT project on girls, physics and technology. The course has been taught only one season, and stopped because of a lack of participants.

A new strategy has gradually replaced the equal opportunities courses: a strategy to incorporate equal opportunities issues in other courses. Incorporate is a positive term. The process was more often conceived as 'hiding'.

The disadvantage is that no one course on gender issues in the school is offered any more.

The advantage is that at least some people get confronted with gender issues related to their specific interest. Thus, some issues on equal opportunities have been included in the courses for general technology, for information technology, in the courses on guidance and counselling, and in courses on management.

Content of modules

This strategy is also used in the project described. Here, modules are developed on several topics regarding the choices and careers of girls (and boys).

A module can be taught in about 3 hours. It can thus be taught during one session of an in-service course.

The modules deal with choices of girls and boys, with an emphasis on non-traditional choices for women. They address those teachers who have direct contact with the option process: the counsellors and the science teachers.

Three questions have guided the development: who is choosing; who is teaching; what is taught. Thus, apart from the option process itself, the modules deal with the role of the teachers, the influence of their attitude, behaviour and expectations, and with curriculim abd teaching methodology.

The modules are not yet completely developed.

The following topics are planned:

1. Option processes

Facts about girls' options

Statistics

What are the effects of options: which subjects are needed for further study

Theory on option processes;

theoretical models,

role of different factors

Research in the Netherlands

The teacher:

attitude, behaviour, expectations

Effect on students

Schools with 'good' practice

2. Information and organisation

Methodology of information and counselling

Effect of information

Information on what

Where to find information: materials; films

Womens' groups; addresses

3. Curriculum

curriculum, examprogramme; attainment targets;

textbooks; tests

Girlfriendly teaching methodology

Laboratory

Single sex grouping

The teachers

In the design of equal opportunities courses for a certain group of teachers, it is important to know some of the characteristics of the target group, in terms of gender issues.

Not much research has been done in the Netherlands on opinions on and practice of equal opportunities by teachers.

Jungbluth (1981) investigated the opinions of teachers on sex equality. His conclusion was that most of the teachers noted differences between girls and boys, but did not think that was a problem. The differences perceived were differences in behaviour (girls work harder, are more quiet in the class), in performance (boys better in math). Teachers were most of the time not aware that education contributed to the maintenance of sex-specific careers at the detriment of girls.

Jungbluth's study was done around 1978, in the very early years of the equal opportunities policy. A more recent study into the choice of mathematics by girls, in which also the sex-specific opinions of mathematics teachers were investigated, still confirmed Jungbluth's results, in this case for the mathematics teachers (Kuyper and Meulenbeld, 1988).

A recent study into the practice of equal opportunities in primary education showed that practically all teachers in primary education think that schools have to play a role in abolishing differences between girls and boys. Whether teachers really take action depends on personal factors as political progressivism, and on the social class of the students (less action with lower class students) (Van Paridon and Vlug, 1989).

One of the equal opportunities issues considered as 'problematic' for girls, is their lower participation in science and technology education. This reduces their future possibilities in a labourmarket where more and more jobs are created in the technological sectors.

There is almost no teacher any more who, in 1990, does not know that their lower choice of math and science by girls is considered as a problem. This is due to a series of mass campaigns.

One, the "Kies exact" (Choose exact, i.e. natural sciences), has been organized by the Ministry of Education and Science, and goes on since 1987. It consists of periodic tv-spots, of posters in the streets, on buses, of advertisements in mass media, and of special brochures for teachers and counsellors, and for students.

The other campaign is organized by the Ministry of Social Affairs and Labour and aims at 'seeking women for men's jobs'.

The Kies exact campaign, in which counsellors were especially addressed, has led to an almost complete awareness among them of the fact that still fewer girls choose math, science and technology.

Little is known at this moment about their knowledge about factors determining this situation or about their willingness and ability to take action, as a group.

There is a definite interest:

conferences for counsellors on equal opportunities are well frequented.

The same can be said of the math teachers and the science teachers. Teachers associations of both disciplines have active womens' groups, who regularly organize conference days, considered as in-service training. They meet with interest from their male colleagues.

So there seems to be ground enough for asking more systematic attention for equal opportunities of all students for all studies.

If we summarize:

the choice for modules, their intention and their content, have been determined by the factors: educational situation of the students; the structure of in-service training, and previous experiences with in-service courses on equal opportunities; the teachers and counsellors and their attitude towards equal opportunities, and their school practice.

International transfer

The previous text has, on purpose, cited only Dutch research. In order to examine transferability, the situation in each country must be examined on the three elements: students - in-service training - teachers. If there is much in common, texts can be used internationally, with some local adaptation.

If we look at the topics that deal with guidance, it must be concluded that this is not a topic that can be easily transfered. Many issues depend on the local context: how is the education system structured; are there options in the system. Specific information is also country bound.

More general are topics like: models of academic choice;

methodology of counselling.

More transfer potential has a module dealing with curriculum: its information may be more general and more educational on many points.

Conclusion

Our conclusion from this case study on in-service modules dealing with non-traditional choices is that experiences from one country can serve another country. In some case materials can be transfered; in other cases, only structuring elements can be pointed out, and the adaptation has to be done locally.

Unfortunately, this is the case for one of the most urgent things: the counselling and guidance of students.

We started with the international framework on equal opportunities in teacher education of the ATEE. If we think of internationally developing topics of the curriculum framework, issues like curriculum content, theory on models or methodology, can be developed internationally. Issues concerning guidance are, as we have seen, much more problematic.

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PROFESSIONAL DEVELOPMENT OF TEACHERS FOR GENDER EQUITY: WHAT HAVE WE LEARNED AND WHERE ARE WE GOING?

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In 1988 Faith Dunne and Toby Rose produced a report for the OECD on implementation of sex equity policy in the United States and Australia. Their particular focus was on pre-service and in-service teacher education. What they found was that the State and Commonwealth sex equity policies which have emerged in Australia since the mid-seventies have produced little effect in institutions responsible for pre-service teacher education and have had only limited effect on in-service teacher education.

These findings are of great concern, and are in contradiction with Australia's major legislative reforms and policy declarations addressing gender equity, (see for example A National Policy for the Education of Girls in Australian Schools (1986), Policy on Girls and Women in Science Education (1987)). Regrettably these policy statements appear to have produced little to date in terms of "teeth" or incentives to ensure action. Indeed it is clear from recent experience that a legislative and policy mandate for gender equity, although immensely valuable as a legitimising agent, is simply not enough to produce deep-seated changes in educational practice or greater sex equity of outcomes, especially in mathematics and science. A mechanism for institutionalising the legal framework and the piecemeal educational initiatives already in existence is needed urgently. Logically, such a mechanism should involve the provision of pre-service and in-service teacher education which produces classroom teachers who

- understand sex equity issues
- know how to create gender-fair classrooms
- have made a personal commitment to equality between the sexes
- are well prepared to act as agents of change, understanding, for example, the increased vulnerability of the already more vulnerable groups (such as females, rural students, etc.) at times of change.

The position of this paper is that fundamental reform is required before the mandated policies will be translated into practice. In the case of teachers, this requires a recognition that they themselves are powerful agents of socialisation, who typically act also as agents of cultural reproduction. They need to be made aware that their role in perpetuating cycles of cultural reproduction may be dysfunctional for many of their students, especially in relation to studies and careers in science. They also need to be made aware of their potential as agents of change in this regard. Generally this will require a change in teachers' or trainee teachers' attitudes, beliefs and expectations about gender differences in social roles and positions.

This paper maintains that effective programmes for attitude change require co-ordinated, relevant and accurate information about the issues identified as important, together with strategies to facilitate the acquisition or enhancement of the desired attitude. It is recognised that attitudinal change does not necessarily follow the presentation of information, no matter how relevant and compelling that information might be. For change to occur, teacher educators and teachers must confront their own attitudes and perceptions and be given opportunities to challenge and change them. Teachers can then be given assistance to develop a repertoire of skills and strategies to deal with gender inequities in their classrooms.

The remainder of this paper considers a number of models for producing teachers with the qualities outlined earlier. As will be seen from the discussion, at the overall institutional level the models remain largely untested. At the programme or classroom level, however, many have been tried and some of these trials have been evaluated.

AT THE INSTITUTIONAL LEVEL

The prospect of reforming Australia's tertiary institutions so that they provide an environment for teacher education along the lines proposed above is daunting.

As found by Dunne & Rose (1989) the content and delivery of the curriculum in tertiary institutions tends to be highly resistant to gender-equity issues, except for somewhat isolated pockets of action. Nevertheless, two possible models for reform will be outlined briefly. Both require a major paradigm shift and both are radical and challenging.

The first possible model is derived from Laird's (1988) philosophical discussion of reforming "Women's True Profession", in which she argues a case for "Feminist Pedagogy" in teacher education. Laird challenges taken-for-granted assumptions about teachers and teaching. She argues that recent inquiries into teacher education in the United States (eg. the Carnegie Forum's A Nation Prepared : Teachers for the 21st Century, (1986) and the Holmes Group's Tomorrow's Teachers (1986)) have missed the point. They have called for a restructuring of schools and of teaching as a profession so that more intellectually able people are attracted to teaching. However, they have not called for any reconception of teaching or teacher education which acknowledges the fundamental point that the "true" nature of teaching must be recognised as a form of child-rearing. Laird and others argue that feminist pedagogy, in making this recognition, has great potential as a basis for transforming teacher education.

To take for granted that teaching is a gender neutral occupation and to frame reforms within a male model of work is in Laird's view patently false. To accept without question that "real" work is based on "rationality, order, detachment and the pursuit of profit/power above personal and emotional attachment" (Freedman, 1987), and to promote the reconception of teaching in these terms, only serves to place real work (eg. school-teaching) and child-rearing in opposition to one another. Because able young women and men are more attracted to business, industry and other professions than they are to teaching does not imply that if teaching were changed to resemble more a market place value structure it would attract able young people.

Feminist pedagogy acknowledges explicitly the need for "the three C's of care, concern and connection" (Martin, 1982 : 408) in teacher education programmes. Its classroom scenario is characterised by "a net of relationships with people who care about each other's learning as well as their own" (Shrewsbury, quoted by Laird, 1988 :460). Its curriculum is conceived as "a conceptualisation of knowledge as a comparision of multiple perspectives leading toward a complex and evolving view of reality" (Maher, quoted by Laird 1988 : 461).

The second possible model at the institutional level is Shalala's "Madison Plan" for the University of Wisconsin at Madison (reported by Barry, 1988). Shalala believes passionately that "you can't have a world-class university ..... unless it truly comprises a diverse student body, faculty and staff, and the curriculum reflects that fact" (Barry 1988:7). With this vision she is in the process of changing the whole corporate culture of her institution. Her aim is to produce a non-sexist, non-racist university, responsive to diverse points of view, which she regards as the ideal learning environment for the 21st century . She does not see tertiary institutions as simply reflecting the larger society. She sees them as the moral leaders of society.

Neither Laird's nor Shalala's models for reform could be described as piecemeal, modest or comfortable. They obviously think in bold strokes - one at a theoretical, the other at a much more practical level.

The implications of these models for science teacher education are clear. In particular they point to the need to integrate scientific and technical studies with the so-called "foundation studies", so that the relevance of the latter to school practice and to teachers' own conception of teaching is explicit. They also point to the need for sensitive staff to transform allegedly rigorous, economically motivated teacher training into teacher education which acknowledges learners' needs for "care, concern and connection". As Freedman (1987) says, the alternative panacea of "transforming women's true profession into a male model of detached professionalism will not work" (quoted by Laird, 1988:459).

AT THE PROGRAMME/PROJECT LEVEL

At the programme/project level the situation is a little more encouraging than at the institutional level. Indeed, Dunne & Rose (1989) found that district-based programmes, especially, appear to have certain advantages related to sensitivity to particular needs, knowledge of pockets of resistance, credibility of personnel involved and continuity. Potentially, in this approach, there is commitment of a group of people at the point of implementation rather than one lonely person struggling against almost insurmountable odds.

At this level many initiatives have been tried, some by members of the GASAT community. Examples are: the large scale Girls Into Science and Technology (GIST) Project in the Manchester area, UK (Whyte, 1986); the Girls and Physics and Technology project in the Netherlands (de Leeuw & Raat, 1987; Lensink, 1983); an attempt to enhance biology student's attitudes to science through a Teacher Intervention Programme in mid-western USA (Mason & Kahle, 1989); and an in-service programme for the nonsexist teaching of physical science in the primary schools of Western Australia (Parker and Rennie 1985, Rennie et al, 1985).

All interventions had as their aim the increased participation of girls in science (particularly physical science) and technology through changing teacher attitudes and hence the way science is taught in the classroom. Two studies (Mason and Kahle, 1989; Rennie et al, 1985) attempted experimental research designs, using in-service and teacher visits and support materials. One (Lensink, 1983) focused upon curriculum development without a formal research design for the evaluation. The fourth, and most extensive study (Whyte, 1986), used "action" and control schools, employed workshops, curriculum development and classroom observations among other strategies, and evaluated success both internally and externally. In every programme (although this is made explicit only in the Rennie et al project) the aim was to persuade teachers to change their attitudes and beliefs to be more in tune with those of the research team.

Recently, Koballa (1989) has considered the concept of persuasion as it relates to science education. He defines persuasion as "a situation which is marked by the conscious intent of the source to persuade and in which both the source and receiver function as active agents in the persuasion process" (Koballa, 1989:23). There are two important elements in this definition. Firstly, there is the conscious attempt to persuade. Koballa (p.4) quotes Miller's three outcomes of persuasive goals : response-change, response-shaping and response-reinforcing. In the context of this paper, response-reinforcing would occur when teachers already possess attitudes congruent with those desired, and response-shaping occurs when teachers with neutral or ill-defined attitudes are led to formalise their attitudes in the desired direction without anticipated resistance. Response-change, however, connotes conflict. Presently held attitudes must be challenged and changed.

The second important element in the definition is the recognition that both the source and receiver are active agents in the persuasion process. This recognises (as Koballa points out) that persuasion is neither indoctrination nor brainwashing. To the extent that the receiver must process the message or information to evaluate its reasonableness, he/she is involved in the construction of his/her own attitudes and beliefs. Further, the process of persuasion requires communication which is a two-way social exchange, not simply the one-way transmission of a message.

Koballa (1989) argues that the cognitive processing and social exchange models present useful extensions to the earlier information processing model for persuasion based on learning theory, although the latter has been used as the basis for research in science education (Shrigley, 1978, 1983). In fact, one of the intervention projects described above (Rennie et al, 1985) made explicit use of the persuasive communication model described by Shrigley (1983), and attributed the success of the project to its use. Each of the other intervention programmes used elements of this model but did not explicate them. For example, in each case, as part of the persuasion process, information was provided to teachers about their own students.

It is clear from the evidence provided from these projects and others that projects must be designed so that, in addition to ensuring the credibility of the message, teachers are given the opportunity to evaluate it, accept it and incorporate it into their own attitude and belief systems. Thus there must be opportunity to challenge and discuss, a procedure to try out and observe the effects of implementing a strategy, and a mechanism for keeping the message in mind (preferably with flexibility for growth), such as support and feedback from the project team, curriculum materials, and a measure or reminder of progress. Unless such a total approach can be implemented, it is unlikely that the message will be adopted and the outcomes will be long term.

THE WAY FORWARD

This paper has discussed two levels of solution to the problem of operationalising the existing legislative and policy mandate for gender equity, especially in relation to science teacher education - the institutional level and the programme/project level. In the former, it must be remembered that in practice, any paradigm change such as that implicit in the Laird and Shalala approaches does not come easily. Theoretically, change could be forced upon institutions either by threat of withdrawal of resources or by provision of incentives to change. However, a coercive approach is unlikely to be successful, partly because it would be perceived as a threat to academic freedom. By contrast, the more benevolent "persuasion through incentives" approach could, and perhaps should, be used.

In seeking a way forward, the temptation is to virtually by-pass pre-service teacher education (except, that is, for supporting identifiable good practice and model institutions), and to focus on in-service education where the prospect of success is brighter, and where diverse situations can be accommodated.

Any approach, of course, has its limitations, because in essence one is attempting to change society by changing what goes on in schools. These limitations have been discussed by Kelly (1986), Yates (1986) and Dunne and Rose (1989). In addition Collins (1988) highlights the sound research base which now underpins professional development of teachers and the enormous amount to be learned from the Australian Schools Commission activities in this area during the late seventies and early eighties. She emphasises in particular the ineffectiveness of programmes which are imposed on schools by a remote bureaucracy insensitive to local needs and programmes which are one-off, and one-teacher-centered, with no systematic follow-up. Effective programmes are found to be those which enable teachers to "diagnose their own learning needs, plan much of their own learning, have the opportunity to try out, discuss, observe others, reflect, evaluate and rediagnose", activities carried out in collaboration with selected and credible facilitators. Collins highlights several needs: the need for schools to be structured and operated in ways which allow space and time for collegiate models of professional development and build such models into the normal cycle of schools' activities; the need for long term and reliable funding to support professional development; and the need for teachers to examine their own taken-for-granted assumptions about schooling and their own stereotypical expectations and explanations of student behaviour.

V SUMMARY

This paper began by highlighting the urgency of the need for preservice and in-service teacher education in Australia to confront gender equity issues, particularly in relation to science. Two levels for action were discussed - the institutional level and the programme/project level and a strong case was made that, while the former level should not be ignored, the best course of action should involve a systematic approach to the latter level. In particular it was argued, from a strong research base (eg. Rennie et al 1985, Collins, 1988, Dunne and Rose 1989) that for professional development to be effective it must

- be based on needs defined and initiatives taken at the school or local level, with the processes of definition and planning supported by selected expert, credible people
- be accompanied by a reorganisation of schools to accommodate a collegiate approach
- recognise that attitude change and the institutionalisation of new ideas and strategies require time for reflection and practice.

Author's note: This paper is condensed from an Invited Commissioned Paper produced for the Australian Government Discipline Review of Teacher Education in Mathematics and Science. The views expressed are those of the authors.

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WOMEN AND TECHNOLOGY: An Overview of Women's Initiatives in Appropriate Technology for Income-Generating and Home Improvement.

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ABSTRACT.

Concern with full participation of women in science and technology and in gender role changes has commanded heightened attention in public and private consciousness of many people. Technology is seen today as the key for social transformation and for self transformation as well, and that's why many women are accepting technological developments and are seeking new development initiatives which will change their position in the society. This paper gives an overview of an ongoing research project under a similar title. It reviews briefly and rather generally women's efforts in initiating appropriate technology activities in their daily attempts to improve themselves and their families. The paper also identifies some obstacles women have encountered and presents some observations about possible implications of technology for the personal lives of women and future strategies for women and technology.

1. BACKGROUND.

The women, who are very industrious, have a number of roles within the agricultural and economic sectors in many developing countries. They are responsible for as much as 80% of all agricultural work. In addition, most women haul water and fuelwood for home use and tend to poultry and animal husbandry. Women are not only predominantly responsible for their families' food supply but also for their children's education and the general welfare of the whole family. As producers of goods and services, women are involved in a variety of income-generating and home improvement activities. Such activities are based on the assumption that it is both desirable and necessary for women to earn their own incomes.

Women's contributions to national development, however, are often overlooked. As a result, they are given limited access to the technologies, training, credit and investment which could ease their workload and increase their productivity. Women's desires for less laborious methods of planning, gathering, cooking and serving food and supply of water and fuel have resulted in innovative initiatives in appropriate technology in many countries.

Over the last decade women themselves have been developing strategies to improve their economic position and of their families, especially through new models of enterprise, organizational practice, self-management, co-operatives, and support networks to exchange ideas and experiences in income-generating and home improvement. They are deeply concerned with their roles in rural and urban communities that are many and varied and in many cases lend themselves to the utilization of appropriate technology techniques and processes.

In spite of some shortcomings in technological change, women utilize indigenous and external technologies in performing their daily tasks within and outside the household. Marylyn Carr (1981) referring to protests in West Africa against the introduction of palm-oil mills, wrote:

> "The myth that rural women are resistant to changes brought about by the introduction of new technologies is obviously an over-simplification of the true situation. Women who are working up to 16 hours a day to provide the basic essentials of life for their families are unlikely to reject anything within their access which could improve their situation as they perceive it. If they do reject a new technology, it is almost always because it is one which would make the current situation worse than better".

Women represent a pool of technological knowledge in preparation of foods, farming, livestock raising, gardening, indigenous medicine, some aspects of education, cottage industry production, and many other fields. Their desire to continually change and improve their social and productive position can be brought through the adoption of new technological achievements, re-orientation of energy systems to renewable sources of energy, introduction of new elements into financial systems, and the popularization of scientific knowledge and thought. Women are striving toward technological competence in knowing how to extract, from technology, the means sufficient for the necessities of life. Women must respond to the challenge to direct, organize, choose, and orient technology to meet individual, family, and societal needs.

Women are basically interested in a variety of appropriate technology developments aimed at improving the social and economic conditions of their family members and their communities. Income-generating projects are gaining popularity due to an increasing need, on the part of women, to build a financial and social support system which fills in gaps left by changing gender roles. Women, particularly in developing countries, have come to realize that their drudgery can be relieved through a combination of appropriate technology and a diversion of time into profitable income-earning and home improvement activities. The sharing of these technologies, most of them very simple, can lead to improved standards of living.

2. THEORETICAL FRAMEWORK.

During the seminar prepared by the NGO Committee for the UN Decade for women (1978), the participants stressed the need for increased involvement of women, especially poor rural and urban women, in planning and implementing programmes which respond to the needs of these women, as they themselves perceive them. O'Kelly (1978) observed that women have the major responsibility for fetching and carrying water to provide for irrigation and domestic use in Kenyan rural homes. The majority must travel three or more kilometres, several times a day. Tinker (1980) suggested that the greatest need is for those technologies that would simplify household-food-chain activities of third world women. What appropriate technologies have these women developed or adopted to simplify household tasks and to improve rural water systems?

The development of technological aides for rural women has been recognized as essential to bridging the increasing gap between men's and women's status, productivity, and work roles (Newland, 1979).

Appropriate technology provides simple solutions to improvements on work tasks performed in the traditional manner. It encourages community self-determination and self-reliance. When community members are involved in the choice and development of technologies, it is much more likely that these will be integrated into daily life (IWTC, 1984). Appropriate technologies have assisted many rural women in keeping chicken, goats and other animals which cater for the local market and generate extra income to improve their families. Many income-earning activities for women, based on traditional crafts, have been developed or improved through appropriate technology.

As the importance of new technologies has become evident in the lives of women, they are waking up to the realization that not only do they want a fair share of the benefits of modern, appropriate technology, but they are also quite capable of coming up with technological innovations, running them, and contributing to their improvement (IWTC 1984). There is an increasing recognition of the contribution made by women in developing countries in their efforts to promote full and equal participation of women in appropriate technology developments.

3. WHY APPROPRIATE TECHNOLOGY DEVELOPMENTS?

SOME EXAMPLES.

Women are beginning to realize that they must take the initiative to make themselves heard and participate in technological developments. In their efforts to become visible and active partners in development, women have formed self-help groups. In Kenya for instance, there are more than 14,500 women groups today, that were created as self-help groups for socio-economic and cultural projects. The groups consists of mostly women who, due to a variety of personal crises, were formed to initiate income-generating ventures for their family's survival. Most of these women have limited skills, training and lack of experience. However, most women groups have been instrumental in initiating, and mobilizing support for income-generating and home improvement projects. Women are motivated to form self-help groups because they see the development of specific resorces as ways to generate income to improve their families.

3.1. Income-generating.

Many women are oppressed by poverty. Thus, there is a great need to identify the socio-economic structures that keep women poor and powerless, and to build alternative structures. One strategy leading to this goal is to organize women to become self-reliant through income-generating projects.

Women groups have identified income-generating opportunities involving application of technology. Women have a strong desire for achievement which often involves creating new areas of economic activity, taking risks and seeking technical competence through training and experience. They produce goods and services needed by their communities and make major contributions to national economies.

3.1.2. Why participate in income-generation?

There are various reasons why women participate in income-generating activities. Among the most common reasons are:-

a) to earn money for taking care of their children and to improve their home environment.

b) to put into use their varied skills and talents

c) to achieve economic independence and a strong influential personality.

d) to eliminate the barriers that often exist with achieving a work environment more compartible with family responsibities.

3.1.3. Some Examples of Income-Generating Activities.

Women in the tiles and building blocks projects.

Women from Mathare in Nairobi, Kenya work with much dedication and determination borne out of many years of poverty. The group members are making roofing tiles using appropriate technology methods for 1,200 housing units in one estate in Nairobi. The tender to supply these materials was awarded to women in line with the governments policy of developing local inputs. Mosombor women group on the other hand are making building blocks for the construction of their own retail shop.

Women in Beekeeping is an excellent self-help activity that can help to meet the urgent needs of the rural populations by providing nutrition and more income. Beekeeping, which traditionally has been men's work, is one of many activities being undertaken co-operatively by village women, Kibwezi Women's groups are well known for this project in Kenya. Appropriate technology have assisted in the adaptation of beekeeping equipment to suit women. The hives not only produce increased yields of honey but also make extraction simple because the new hives stand only a few feet off the ground.

Other income-generating activities. Women groups own maize shellers,grinding mills and small shops, such as bicycle repair, welding services, shoe repair, retail clothing and craft stores. Besides financial benefits acruing from these activities, women enjoy other non-quantifiable benefits that include economic independence, and a strong, influential personality in the community. These activities are favoured because they are compatible with other household responsibilities and have flexible work schedules.

3.2. Home Improvement.

Women participate in income-generating activities to raise money to improve their standard of living. Through the utilization of better technologies, women in developing countries are improving their home environment. They are active participants in household energy conservation, biogas utilization, water and sanitation programs, food processing and preservation methods and many other projects.

Household energy technology. Women, being the main users of household energy, are in a position to investigate apportunities for adapted technologies, fuel conservation and labour saving through improved or new sources of energy and through the utilization of better technologies. Women are involved in energy technology planning as they build improved, efficient smokeless stoves and fireplaces. Also in using appropriate utensils and better methods of cooking.

Biogas. Biogas is gaining popularity among some women groups. Women are themselves installing biogas plants in their homes for cooking and lighting. The problems that affect women are the high costs of setting up biogas and installing appliances such as stoves and light fixtures. But, with a group effort, they hope to eventually install a biogas plant in each of their members homes.

Water and Sanitation. Improving water and hygiene conditions in the home will definitely benefit women and their communities. Women play a dominant role in introducing family members to hygienic practices and habits related to water and sanitation. Women groups have initiated and are involved in clean water supplies and sanitation programs at various levels. Despite some problems and constraints that limit their full participation in decision-making process and development, women's involvement in planning and applying improved technology in water supply and sanitation is important. Labour-saving devices such as water pumps and distribution systems free women from long hours of fetching water and, hence, give them time for income-generating activities.

Food Processing and Preservation. Relevant labour-saving equipment helps women with time-consuming duties such as processing grains, preserving vegetables and fruits and storing harvested produce. Various women groups own maize shellers and grinding mills which can convert large quantities of grains into flour in minutes. Women groups are also involved in developing storage methods using appropriate technologies. Some of the improvements include raising the storage crib off the ground and coating baskets with cowdung.

4. IMPLICATIONS OF APPROPRIATE TECHNOLOGY FOR THE PERSONAL LIVES OF WOMEN.

Though their contribution is still largely invisible, women have contributed positively to enhancing the impact of technology on the development process. Women are convinced that technological changes will exert pressure on the traditional roles causing sex stereotyping to decline, thus paving the way for a broader, deeper participation of women in developing their families and communities. Women uphold the promise new technologies hold for the emancipation of women from work that is meaningless and monotonous.

It is observed, however, that in order to enable more women to derive economic benefits through employment generated by technology, more opportunities should be created for part-time work and flexible work schedules compatible with international labour standards (not exploitative), and the potential of emerging technologies to offer more flexibility should be utilized.

Women need to educate their counterparts worldwide in both rural and urban sectors to identify and understand the most vital development needs of the society as a whole. Only then can they appreciate the extent and potential of their own knowledge, be it traditional or not, and learn more about new technological developments.

One positive example is seen in communities and villages where piped water projects have been completed, women are happy as they can get more time to attend literacy classes and to do other productive work and improve their families. Their families health has improved as women get lessons on hygiene and good sanitation. The standards of living in their homes have also improved.

The increasing involvement of women in appropriate technology for income-generating and home improvement have improved their status of financial independence. The majority of women are gaining some ecônomic leverage, sense of autonomy and self -confidence required to reach full potential and to stand as an equal with others in society. Some women, however still face barriers that have hindered their success. These include:-

1. lack of technical training needed for managing and maintaining their projects
2. lack of managerial skills in accounting, marketing, finance and also in personnel and time management
3. lack of confidence in women leadership in new areas of economic activity
4. tension between personal life and career
5. lack of education especially in science and technology
6. stereo-typing of sex roles due to the sexual division of labour
7. corruption, as in using financial assistance or organization of funds for purposes other than what the funds have been allocated for
8. problems in marketing, which may be overcomed by conducting a feasibility study before starting any income-generating project.

5. SOME CONCLUSIONS AND RECOMMENDATIONS.

Some of the recent technological innovations, have made modern technology potentially more accessible to women. These have had an impact on the current production, transport, communication and distribution models in developing countries. Women today play a bigger role in promoting and disseminating technology. More women are participating in planning, designing, manufacturing, managing and use of new technology.

Where it has been demonstrated that a new technological introduction can reduce menial labour and make life easier without an added financial burden, women have accepted new inventions especially those that do not involve structural complexities. Women have come to realize that economic growth and social development are closely related to improvement in the techniques used in productive and domestic activities. It is only by changing the role of women in society that society itself can be changed. The first step toward change is the recognition of the true economic role of women and their social role, which presupposes an adequate evaluation and recognition of their work. This may then lead to the establishment and promotion of new development initiatives which would change the developmental position of women and all members of the society.

RECOMMENDATIONS FOR FUTURE STRATEGIES.

The following recommendations have so far been identified in the study:-

1. Women in all walks of life must recognize the impact of technology on their lives and must make efforts to familiarize themselves with gender issues in technology.

2. Concerned women in science and technology should establish linkages with womens' groups to publicize the impact of new and emerging technologies on women's lives.

3. Increased involvement of women in local and regional exchanges and encouragement to their counterparts world-wide to do the same.

4. Professional organizations in developed countries should assist organizations and institutions in developing countries in the publication of national, regional newsletters and journals. Such journals should highlight technological development issues including those related to women.
5. Strengthen collective self-reliance in the field of technological developments and recognize womens' efforts in national development and establish better strategies to promote an integrative approach to the productive role of women.

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THE LIVES AND WORK OF WOMEN WITH ESTABLISHED REPUTATIONS IN THE PHYSICAL AND APPLIED SCIENCES.

Anne Walton.

SUMMARY.

This paper presents a preliminary analysis of nine 'life history' interviews of women scientists with established reputations.

An attempt was made to discover whether there were any common attributes or experiences which would enable them to resist gender stereotyping, to the extent that it was possible for them to choose a profession generally regarded as inappropriate for their sex.

Some basic factual data are given, and a number of factors which may be significant in girls' attitudes to science, examined in the light of the experiences of these mature scientists.

Features of the women's career development are discussed. Direct quotations from the interviews, illustrating their opinions and experiences, are collated under topic headings to ensure anonymity.

INTRODUCTION.

This research programme arose out of a concern that so few girls were choosing to study the physical and applied sciences. It is clearly in the best interests of society and of the individuals themselves that such potential talent should not be wasted. A considerable amount of work has been done to try to remedy the situation, with varying degrees of success. Little attention, however, has been paid to those girls and women who, in spite of all the social and other pressures, embarked on a career in the physical or applied sciences. These are likely to possess particular qualities in that they chose a profession with a 'masculine image'. This implies a measure of self-confidence and strength of purpose which more than compensated for the requirement to conform. If these 'enabling' factors could be identified and women scientists and their work made more visible, girls might be encouraged to opt for science at school.

Moreover, it has become clear that much of the research undertaken by the women scientists has strong humanitarian connotations and is firmly (and obviously) grounded in matters affecting everyday life - thus giving the lie to the 'ivory tower' image of science and the allegation that it is exclusively either harmful or abstract and remote.

In general, the interviewees are middle-aged, 'successful' (professor, reader, senior lecturer), academic or 'academic-related' and with considerable research experience. I have deliberately *not* chosen women Nobel prize-winners, partly because they have been extensively interviewed already, but also I wanted to make visible those women who are *not*, by-and-large in the public eye and whose attainments might seem to be more easily emulated by others.

FACTUAL DATA.

At the time they were interviewed most of the interviewees were in their early or mid-50s. The exceptions were two aged 39 and 40 and one aged 89! The last, whose career began well before World War Two, provides an interesting comparison with the younger women. The two younger who were *born* after the War (and after the 1944 Education Act) offer a different perspective. All were born and brought up in the U.K..

All, except the youngest, who went to a comprehensive school, went to a grammar or similar (selective) school. Five schools were single sex and four were coeducational. The facilities (laboratories and equipment) varied from 'very good' to 'very bad'. So also did the quality of the teaching! In neither case did any clear pattern emerge.

A strong puritan ethic has been identified as characteristic of many men scientists (see e.g. Head, 1985) so eight of the women were asked about their own and their parents' religious affiliations. All were brought up Christian and protestant. One specifically referred to a 'strong puritan ethic' which she felt still influenced her, others were still actively involved in their Churches, others were not. Again, there was no clear pattern.

Seven read physics or chemistry for their first degree. One read zoology but became a biochemist; the other read mathematics but became a computer scientist.

Teachers and parents were invariably described as 'encouraging' though several of the interviewees pointed out that this encouragement was of a general nature and some teachers and parents were anxious about the choice of science, knowing that it was an atypical choice for girls.

Interviewees were asked about their mothers' occupations before and after having a family. Most mothers did not have professional careers, but what came over very strongly was the importance of their *attitudes*. All of them wanted their daughters to do well and, some were determined that their daughters should have the opportunities which they were denied. To use current jargon, one could describe most of these families as 'upwardly mobile', the children making their way into the professional middle class through talent and hard work.

All the women were, predictably, highly intelligent, and all but two were 'all-rounders', with excellent examination results at O-level (or equivalent) in arts subjects. All these were confident that they could have got arts degrees and some did a lot of heart-searching when asked to choose between arts and science; sometimes with parents and teachers favouring the former.

Fathers' occupations were very variable; four could be described as 'professional' but again, it was the father's *attitude* which had the greatest influence.

Six had close relatives working in science or technology; two more had close relatives in medicine. If female, these at least demonstrated to the school-girl that a career in science was *possible*. Others referred to 'strong' women in their family who they felt they could emulate, regardless of their occupation.

Six of the women were married and four had children. Of these four, two were the two youngest - which may be significant.

Seven of the interviewees were either only children or the eldest. One had two sisters who were much older and the other was the youngest of three - the only one with an older brother - and, again, possibly significantly, one of the younger ones. The only, or eldest child may be more likely to make an independent choice and may possibly be more likely to be influenced by her father, if there is no brother to compete for his attention. Several of the women reported spending significant amounts of their leisure time, as young girls, with their fathers.

'Tinkering skills' may be a valuable asset to anyone entering a career in science (Whyte, 1986). Gender stereotyping of toys and leisure activities ensures that most boys acquire these, while girls (at least until recently) may never have the opportunity. Six of the women scientists did have some experience of using tools, playing with construction kits or wood- or metal-work before university. One of the others did home decorating and another acquired manipulative skills doing advanced needlework and embroidery.

EXTRACTS FROM INTERVIEWS.

In a preliminary report and with transcripts exceeding 30,000 words, some selection is essential. A few short quotations, highlighting some of what seem to have emerged as important issues, are therefore given below. The criteria for selection are necessarily subjective, and because my own career in science so closely parallels those of the interviewees, I make no apology for 'the shock of recognition' being one of them!

A major constraint in a project of this kind is the need for confidentiality. A guarantee was given to each person interviewed that her anonymity would be respected. For this reason it was decided to present relevant data under different *topic* headings.

ISOLATION.

It is not easy to untangle whether early isolation was imposed, as it had been, for example, for Lise Meitner (Krafft, 1978) and Mary Fieser (Pramer, 1985), or chance, or chosen. Crystallographers, and workers with other highly specialised equipment, tend to be somewhat isolated, as do theoreticians and mathematicians. Sometimes the feeling of *social* isolation persists.

It is difficult to do things on your own. If you have a supportive partner I'm sure it does make life easier for you.

Yes, I think there is that job satisfaction in that you start at the beginning collecting your data and, with any luck, you pursue it through to the end and come to an answer for which only you are responsible. I think this is really very satisfying.

[A teacher said] *I was probably best fitted to be a hermit. I found people difficult to deal with. I still do up to a point, but dealing from a position of seniority and authority, it becomes easier, I find, than if you're trying to deal from the bottom.*

It wasn't until I moved on after my Ph.D. that I worked with a group of people.......as a theoretician you can work without other people.

THE WORK SCENE.

I think it is fair to say that all the women were attracted to science for its own sake initially. Apart from the biochemist, their early work was in the mainstream of physical science. One was very explicit:

Medicine was to do with dealing with people rather than with science, although you used science. I think I was interested in pure science, making discoveries.

A chemist who says she is more interested in the chemistry, has, nevertheless, worked on environmental projects and with 'bio-materials'. Another, who disliked biology as a young woman, worked on metal complexes of interest in agricultural research. One moved into medical physics while another now advises people on the use of computers in their own work. Several now spend much of their time on administration and management and also on encouraging girls to consider a scientific career.

The more people-oriented work fits the model of female psychology put forward, for example, by Gilligan (1982) and Keller (1983 and 1986), much better and it is tempting to speculate that this tendency was suppressed in early life in order to conform more closely with the male scientist 'norm'.

The best way to interest girls in science is not to tell them that they ought to be interested, but to tell them something about what I do.

Yes, I have changed and my attitudes have changed and, whereas, I was much more concerned with myself and my own research and the work I wanted to do in the early years, I have become much more interested in, not only the individuals, but in the complexity of the problems that make up, in my case, for an institution. I am interested now in the complex interactions of the threads of personalities and problems, practical problems, building and finance and planning and policy and people.

It seemed to me that the chance of doing something totally different at the age of 50 is something that couldn't lightly be turned down. It would be rather fun to see what was out there in the big wide world. I can't say I've regretted it.....it's great stuff, doing PR (it's basically a PR job); it's mainly administration and I'm thoroughly enjoying it.

I was actually very pleased to switch to this [people oriented] *field....it's been very rewarding, particularly because it involves a good deal of team work....It really is a close collaboration between experimenters and theoreticians.*

MOBILITY.

A lot of lip-service has been paid in the past to the notion of 'academic mobility' and it was one way of mounting the promotion ladder. It is perhaps worth noting, therefore, that all the interviewees have spent all, or nearly all, their working lives in one institution. One settled in a particular city because her husband's job was there but that does not seem to have been a dominant factor with this group. The following quotations suggest another possible reason which I think of as 'the devil-you-know' syndrome!

...my colleagues in the department - they're so used to me - I don't think they think about it. Outside the department, it's curious; I think the attitude is a bit confused.

[My promotion was] *very well received by my male colleagues. I think it would have been hard for a strange woman to come in from outside but since they knew me they had formed their opinions of me as a person.*

.....they tended to make reader and professor appointments from outside but I think for a woman her best chance is with people she knows.

DOMESTIC RESPONSIBILITIES.

....if I hadn't had the additional responsibility of small children at home to concern me, I could have pressed harder. I could not only have put in more time but I would have pressed harder for various promotional stages and so on up the ladder, and I think it would have been harder to resist had I been male.

I didn't actually take out much time to have children; I took about three months off with the first and the rest I carried right through... I always felt that I was the one, if anything had to be dropped to look after the children, I was the one who dropped it.... Even when they were older, if there was a school sports day, it was always muggins here who took the afternoon off and went to *the ruddy school sports - never father. Father's job was too important to take time off to go to the school sports.....I had parent problems too.*

Whenever anyone talks to me about career break, I talk about career disruption and I say that an emotionally dependent, elderly person can be as demanding as an adolescent, as a child, and you don't really make a conscious choice. At least, I suppose there are some people who could walk away, but not many women.

If you're doing something and it's running on in the afternoon, you can't stay on; you've got to get home, so that lack of flexibility took a bit of getting used to; but my husband was particularly good and we shared the going home.

LOW ASPIRATIONS, INVISIBILITY AND CONFIDENCE.

There is a package of attributes and effects which centre around the 'confidence' theme. It is extremely complex and there is a high degree of ambivalence. For example, the women in this study were very confident *academically* at school but, as the section on isolation suggests, they were not so confident socially. Even academically, they underestimated their own ability. One said she laughed when a teacher suggested that she might be a university teacher, rather than a school teacher. The idea of doing a Ph.D. had not even occurred to another. Yet another thought she was not very good at experimental work because no-one had bothered to tell her how good she was. Two, having said in their interviews how easy they found maths, went on to say that they rejected certain options because they were not sure their maths was good enough, though both of them subsequently used maths extensively in their careers.

I think all of them knew that it was essential to *appear* confident as their careers progressed. People who display self-doubt are unlikely to be promoted. However, a number talked about anxieties which had troubled them earlier in their working lives and the strategies which they had used to overcome them. It is actually quite daunting, as a young woman, to find oneself in an exclusively male world and the problem does not go away entirely, even after many years of successful integration, as the anecdotes quoted below show.

...when I was younger, I couldn't push myself at all. I never felt I could be good at much...I just made myself do it.

I wondered whether, to get on, to get into what is seen as a man's world, you have to be a bit more forceful in the first place...

'F'...you had to convince people that you were serious

'A'. How long do you think that took you?

'F'. I think I'm still trying!

'A'. Even now? You still feel that?

'F'. Yes, certainly. I still feel it's a disadvantage being female in an academic environment, because there are so few.

Luckily, I have learned that the important thing was to get up and say something, doesn't matter what nonsense it was but if you got up and said something, then you finished up on the committee. I was always very reluctant to stand up and say something unless I had something useful to say, and if everybody followed that rule, meetings would be much shorter....I've learnt now to say 'do not interrupt me', which they do all the time.

One doesn't want to state this really too highly but I always got the impression in the early days, when you wanted to make any kind of statement at a meeting, that that was the time they chose to pass the coffee and biscuits.

The first time I was treated as a non-person - we had a visitor - I was interested in his work. He just didn't pay any attention to what I said. A *colleague...tried asking the questions that he had heard me ask, and then he got answers and he said to me afterwards...'I hope I asked the right questions'!*

...you say something, and nobody pays the slightest attention, and ten minutes later, a man says the same thing and it's greeted as a good idea, so you realise your idea wasn't so bad after all!

[On women research students] *I would have said they're quite as good as the men, if not better. The only difference generally as assistants is that men...seem more self confident, anyway....you throw out half an idea, and the next time you see them the apparatus is under construction....*[As for the women] *the background is so different...there's been no Do-It-Yourself in the house, probably; no use of things in the workshop, and, therefore, it's much more difficult to start to construct the apparatus.*

So 'tinkering' is a confidence-building exercise - a piece of positive guidance on which to end!

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Women into Science and Engineering (WISE): Activisim and Institutional Change.

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Summary

For the last four years the authors have worked as joint Chairs of the Open University (OU) WISE Group. It operates with the support of a dozen active women and men, and a large mailing list of passive members. Over the years we can claim a number of achievements for the Group, but there are areas where we have made little or no impact on the University. In this paper we begin to analyse why we have been successful in some areas of work and not in others. We feel that our own experience of sustaining a feminist pressure group in a liberal, but bureaucratic, academic institution will be familiar to many people working for women's education in science and technology. We need to share our understanding of institutional power to be better able to develop feminist strategies for achieving institutional change.

The Institutional Context

The OU is a national distance teaching university, the largest provider of undergraduate, postgraduate and adult education in Britain, with 100,000 adult part-time students in 1988. It was established by a Labour government in 1969, in a period of expansion in higher education. The key educational principle of the OU, alongside its distance teaching methodology, is equality of opportunity through open access. This policy was stated in the government White paper *A University of the Air* (1966) which laid out plans for the University:

> *"Enrolment as a student of the University should be open to everyone on payment of a registration fee, irrespective of educational qualifications, and no formal entrance requirement should be imposed." (quoted in McIntosh 1977:3).*

This was enshrined in the University's charter, and undergraduate courses are carefully structured so that no presumptions are made, beyond those of basic literacy and numeracy, about students' educational skills on entry to their first year of study. It was hoped that large numbers of working class men and women would be attracted to open access university education, but this has not proved to be the case. Class remains a general barrier to access.

In particular subjects, gender is a barrier too. In 1988 women were 46% of all undergraduates, the same proportion as women on full-time undergraduate courses in other UK universities (Universities Statistical Record 1988). However, the proportions studying mathematics, science and technology are much lower, with women being only 16% of all technology students, 26% of mathematics and 37% of science. Such statistics provided the context for the establishment of the WISE Group in 1984; its early work has been described elsewhere (Carter 1987).

Successful WISE initiatives

WISE successes are easy to claim, and very tangible. The Group has been most successful in its promotional activities; the 1980s have seen a steady increase in the proportion of women entering the first year course in technology, from just over 15% to 28% in 1989. Our leaflets encouraging women to consider technology as a subject of study and our careers booklet "Career-wise: a fresh start in technology" (Kirkup 1986), which encourages mature women to consider training for and entering a new career in technology, have been widely used by women studying at local colleges as well as our own students. The promotional work of the Group is seen by the Technology Faculty, in particular, as being good general publicity for the Faculty and so it is supported.

Similarly, the Group organises and hosts a WISE seminar series with invited speakers from both inside and outside the OU. Seminars, which take place on the afternoons following morning WISE Group meetings, are mostly well attended and expenses are met by the Technology Faculty.

Some individuals in the Group have received acknowledgement for their work in this field and are invited to speak outside the University about WISE and the OU, and to join special groups and committees within the University. Sometimes WISE work has provided a visible platform for active and competent women who would be unlikely to have been assigned prominent roles or responsibilities in their day to day work. However, the time needed to do the work is not recognised even when the product is, so most of the group fit WISE activities into the margins of the rest of their work.

In 1989, the work of the Group contributed directly to the OU's reputation as an institution with a record of excellence in women's education. The University won two national awards in this field, one from the Fawcett Society, a group with a long history of working for women's rights, and the other from Good Housekeeping, a 'quality' women's magazine. In the submission for each of these awards, successful WISE Group initiatives were documented together with equally successful women-oriented projects stemming from other groups within the University, the Women In Technology project and the Women into Management course, for example.

The WISE Group has been the longest running of the many different kinds of equal opportunities groups across the University. It was not originally intended as such, since members had more radical notions in promoting women's interests than simply working for equality of opportunity. The University's philosophy of 'openness' has proved a hindrance, at least as much as a help to the work of such groups. For some people, rhetorical commitments to openness have taken the place of developing and monitoring practice. There has also been concern, common where there is a liberal belief in equality, that special initiatives for some disadvantaged groups would lead to inequality of provision. The University as an institution did not acknowledge that it was not providing equality of opportunity amongst its staff, or that in practice it was not providing equal opportunity for access to all potential students, until 1987 when the University Senate supported a motion to establish an explicit Equal Opportunities Policy. A Team was then set up to design the Policy and the structures for implementing it over a five year period. Two active members of the WISE Group were asked to join the Team because of their long experience of involvement with womens' issues. However although their experience has benefitted the Equal Opportunities Team greatly, and their Team work has been acknowledged by the institution, there has been no direct benefit (as yet) to the WISE Group.

Less successful initiatives

While we would argue that almost any initiative generated by a small, committed pressure group in a large educational institution is likely to have some positive effect by the very fact of its existence, there have undoubtedly been areas of our work in the WISE Group which we regard as having failed. Usually, success extends to the boundary where we have control over the outcome of our efforts and are able to continue to influence it, whereas failure occurs when we come into conflict with the institution, or encounter institutional inertia.The group benefits from the traditional ideology of 'academic fredom' and autonomy. We can write, speak, and run educational initiatives, and those who disagree with us will not hinder us, although they might write or speak against us. However, once we try to achieve institutional change that influences the work of others or the operation of the institution, we are effectively members of a large corporation. Corporate ideology and practice is very powerful and self-protective.

For example in 1989, at the instigation of the WISE Group, the Faculties of Science and Technology attempted to change the wording of the advertisement which appears annually in the national press to recruit tutorial staff for OU summer schools. Both Faculties had monitored the gender composition of their summer school staff and wished to insert a sentence in the advertisement to encourage more women to apply. The request was made well before the deadline for the preparation of the advertising copy, but the administrative unit responsible was unsympathetic to the proposal. It took delaying action and attempted to redirect responsibility until the deadline passed and the amendment was not included in the final advertisement for staff for the summer of 1990. The hidden power of conservative administration to delay, dilute or block change is enormous.

On the one hand the institution refused to take legally acceptable positive action on recruitment, yet on the other it had eagerly claimed the Good Housekeeping award mentioned above as evidence of its progressive practice. Having accepted the award on the basis of a submission prepared by the Press Office, the University managed to omit any public acknowledgement of the contributions of the many groups including WISE, whose work had won it. When at last feminist activists should be enjoying that public recognition the University sidesteps them and claims the work for 'The University'.

Working on curriculum change in technology is a long term task, and one where the WISE Group has been disappointed by its lack of influence. Feminist critiques of scientific and technological method such as that of Harding (1986), come from the disciplines of history and philosophy of science and technology. Their impack on the curriculum in science and technology is envitably slow, because it is difficult to translate theoretical critiques into the practical design of new teaching material. Academics in the pure sciences, technology and engineering tend to view their fields as absolutes, providing a correct analysis of the material world in which social constructs have no role. Feminists have begun to challenge these underlying assumptions (see, for example, Keller, 1985, Carter and Kirkup 1990) but it will be many years before science and engineering educators are able to present different maps of each field at the core of their teaching.

Course teams preparing or revising Technology courses have invited and apparently welcomed advice from the WISE Group on non-sexist presentation, content and gender-linked issues, but the Group has rarely been offered the opportunity to comment on print drafts in time to change them, or to contribute to improving the audio visual components of the multi-media OU courses. Not only are we questioning what constitutes knowledge, without as yet being able to provide answers, but we also present a challenge to those who are authorised to produce knowledge. This is a combination which our colleagues find hard to accommodate.

Interaction with the institution

In theory the University manages itself through a system of committee structures which contain representative and co-opted members of all the academic units. Kanter's work (1977) on who has power in large corporate organisations, and why that is less likely to be women, applies equally to large educational institutions. In the OU cases for new initiatives and change must be argued many times through different layers of committees and there are many places where individual committees or University administrators can hinder, if not block, progress. Encountering any key individual or sub-group who is not persuaded that women are disadvantaged in some respects can be disastrous for WISE initiatives. At the same time, this democratic model permits the men in senior positions to claim the success of new initiatives for themselves and for the institution, without acknowledging their origins and development.

None of the women in the WISE Group are senior academics and many members are not on the academic staff at all. We are not a collection of high status members of the University, nor as individuals do we wield institutional power. However, we have been more successful in getting the support of senior members of the University than in getting that of our immediate colleagues. The Dean of Technology, a long standing member of the group, has provided us with status and resources. As we have always had members from several faculties we are, increasingly, able to call on the Deans of Science and Mathematics, and some of our Pro-Vice Chancellors.

As a voluntary group outside the University's formal structure we have no direct access to budgets. Small administrative cost and expenses are met from Faculty budgets, but these do not stretch to supporting any financially ambitious project. We continue to bid, internally and externally, for funding for a variety of projects, with limited success.

At a more personal level, the pressures of time, and of mainstream workloads, always disadvantage voluntary work done by women. The staff population at the OU, as at other UK universities, is static and ageing. Amongst women, this means that more and more are contending with additional family responsibilities which conflict with their professional work and contribute to their overall load, marginalising WISE work even further.

One of the successes and yet one of the weaknesses of the Group has been its determination to be open to members from any Faculty and from a variety of feminist positions. It has been successful in that people work on a wide range of projects together, and feel able to make a contribution. Operating a consensus model has also provided us with more support within the University and an image (with most of our colleagues!) of 'reasonableness'. However it is also a weakness since we have no 'manifesto' or commonly developed analysis of women and technology. But, without one we cannot assess how far we have successfully challenged the University.

A future for WISE?

In the OU, at least, we do not feel that there is a danger of WISE issues being entirely dismissed as trivial or irrelevant, even though we regularly notice the work of the Group being relegated to the periphery of "serious" academia. One of the major reasons for this is not due to the success of our work at all, but to the much discussed 'demographic time-bomb'. Senior members of the University are aware that its survival depends on recruiting students from previously untapped groups of the population such as the working class and ethnic minorities, as well as women into non traditional areas. We may feel cynical and wary of this concern, but we would be short sighted not to use it to our advantage.

To ensure that WISE initiatives have an easier passage through the formal structure of the institution, members of the Group need to accrue more status through promotion and election to the University's many committees. But, fulfilling promotion criteria and sitting on committees take time and energy and can divert our radical intentions. Meanwhile, we provide networked support for each other and we are in touch with similar groups in other colleges and in other countries. Ironically, the Group also provides a forum for the full discussion of curriculum issues.

We will need to be clear headed about our aims for the next 10 years. In the UK we will find ourselves working in educational institutions which function increasingly like business corporations: efficiency and profit become major concerns, tenure ceases to exist and academic freedom has a different, and restricted meaning. Feminists working for women's education in science and technology need to understand their current interaction with their institutions. This will be vital information in the new context, where we will require different strategies for achieving institution change.

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Social Responsibility in Technology and Feminist Visions

Paper for Second European GASAT conference

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Introduction

The issue of social responsibility within science and technology has, also in the last decade, been surfacing in a number of contexts. One of these contexts is feminism.

In this paper I will explore the question of whether feminism, can teach us about how to integrate social responsibility into the proces of technology design. In particular, I will investigate whether the ideas on 'feminist ethics'[1], can help us in analyzing the character and the (non-)functioning of the 'Poco-procedure'. This is a procedure that intends to regulate how to deal with politically controversial research projects[2] at the university of Twente.

My view is that it seems worthwhile to try to integrate normative questions into the process of technology-making. In science studies, it has been noted that groups promoting and stimulating technology growth form one network, while those promoting social concerns and doubts with regard to technology are often located in another network, one that is at a distance from the institutions where technology is actually developed. These two networks barely overlap or communicate, which hampers the effectiveness of the groups promoting social responsibility (Jelsma e.a. 1989). Thus it seems necessary to introduce normative questions in the very institutions that foster technology-growth, that is: 'at the workplace'. This is, however, also a very difficult location for bringing in social concerns, and it is not at all clear which form these should get. One attempt to find a form for the integration of social concerns into university research was recently made at the University of Twente by way of the Poco-procedure.

Expectation

Before exploring whether feminism can offer insights into an analysis of the issue of technological sciences and social responsibility, let me first illustrate why it is not implausible to expect such a contribution from feminism. In the past 15 years, feminism has demonstrated a capacity for analyzing modern science and technology in new and original ways. First, this has happened in the social sciences, more recently it is also happening in the natural sciences. The story of this project - the story of women's studies in its broadest sense - is probably well known. It includes the discovery of the absence of women as object of research and the discovery of the stereotypical treatment of them when they do figure in research. It includes the de-masking of so-called neutral theories as defending the status quo, often involving 'bad research' by its own standards. It has however also questioned the standards of 'good research' themselves. What's important to this paper is that, among the aspects of science problematized by feminism, are the ideologies of science as neutral, and of science as inherently good.

Added to this occupation of feminism with science is the occupation of feminism with ethics. Of course, feminism is itself based on the ethical standpoint that the subordination of women should be undone. Next to this, however, some feminists try to derive general ethical viewpoints from feminism. This will be worked out later in this paper.

Thus there is an intuitive basis for the expectation that feminism may be able to provide a source for thinking about a more responsible technology development. In the following, I would like to defend and illustrate that feminism does have this capacity. First, however, I will argue that such a capacity cannot be founded on a logically necessary link from feminism, understood as a movement to overcome gender-inequalities, to a science generally beneficial for humanity. The idea that feminism provides a basis for general moral principles can, in my opinion, be described as a vital fallacy.

Fallacy:

The adjective 'feminist' has in some instances gotten an evaluative meaning. It could be translated as follows: feminist elements are elements 'that are found more among women than among men and that should also be valued more than men's alternatives'. However, many authors also employ another concept, meant to contrast with 'feminist', which they often name 'feminine'. Feminine could be translated as: that which is found more among women than among men as a result of our present patriarchal culture and should be rejected by women. (Rendel 1984)

This illustrates that elements found among women can be either evaluated as positive or as negative. There is no prior indication for which of the behavior that we find among women is the feminine, which the feminist. The evaluation of female elements as - in a particular situation - 'better' than male elements is very well possible, but must be based on other criteria than its femaleness[3]. From a feminist viewpoint, the criterium will be: will it improve the situation of women in general. Where men and women have wider objectives, such as creating a more humane society in general, the question is: 'what is the more humane way'. To use the question 'what's women's way' as a short-cut to answer the first question is, I believe, a fallacy.

Vitality

Yet, reality seems to show a different pattern. In practice, 'women's ways' have provided an inspiration to look in new ways at a variety of issues, including the issue of science and society (for example: Miles 1984, Fee 1981) Vice versa, people who are occupied with this issue have drawn upon feminism to develop their insights (for example: Capra 1975, Pacey 1983, Chris Boers 1981). If it's a fallacy that women's ways indicate the route to a more humane science, than it seems to be a 'vital fallacy', in the sense that it generates creative and useful ideas to base thinking and analysis on. What is this vitality based on, if not on a logical connnection between the women's ways and better ways?

I think that in relation to this question, the following characteristics of feminist studies are relevant.

Feminism starts out with the commitment to expose gendered thinking and its consequences. One thing that we have learned from feminist studies in all kinds of fields, is that many gender effects are, in first instance, easily overlooked. Exactly because of their overbearing presence, they carry with them the flavour of being both natural (logical, necessary) and right. This makes it difficult to detect and problematize them. Thus the feminist commitment automatically implies a close scrutiny of what seems obvious and unproblematic. It has developed a capacity for radical analyses and for turning the obvious upside down by putting a new light on it.

Thus, the feminist starting point can be particularly effective in breaking open some of the cultural aspects which often appear as necessities. Its context of radicality evokes analytical concepts with a potential for deconstructing the one-sidedness of fundamental aspects of our social world. Often, the negative aspects of such one-sidedness can then be illustrated.

Especially in the analysis of science, doubting the unproblematic and questioning the 'logical' is a necessary aspect of fruitful analysis. As Latour and Woolgar have argued in their book Laboratory Life (1979), the attitude of 'anthropological strangeness' is necessary to understand the workings of science and technology-making. It is not easy to hold such an attitude in the face of 'ready-made science', where long chains of human effort have succeeded in black-boxing controversies and human elements (Latour, 1987).

With the scrutiny of feminist analysis applied to science, feminist science studies have noticed and problematized peculiarities of modern science and technology in new ways. For example, the discovery of genderized metaphors in the work of early propagandists of science illustrated the antagonistic relation between science and nature which lies at the basis of the scientific project, and the obsession of natural sciences with control (see among others Easlea 1981).

Once the obvious and the unproblematic has been broken open, there is room for criticism and for a vision of alternatives. Sometimes feminist thinking has provided a source for the construction of something like Weberian ideal types. This is the case in the example of feminist ethics which will be discussed below.

Thus, the standpoint of vital fallacy used here implies that the basis of the usefulness of feminism for the question of social responsibility in technological sciences does not lie in the equation of 'feminist' with 'better for the world', but in its strong potential to rethink in a radical and original way black-boxed social structures such as ethics and technology development.

Feminist ethics

The discussion on 'feminist ethics' that I'm considering here was started by Gilligan's critique of the stages of morality developed by Lawrence Kohlberg. It is an example of a standard vision turned around as a result of a feminist starting point.

Kohlberg, with whom Gilligan worked, had analyzed types of moral reasoning and ordered these types in a hierarchy of stages. Every person would, in the proces of maturing, supposedly go through all these stages. They would develop from one stage to the next, and in the end, if they managed to fully mature, reach what Kohlberg considered the highest moral stage. This he called the 'stage of universal ethical principles'. (Kohlberg 1981, p. 412)

He then noted that there were differences between his male and female respondents. He concluded that women more often had a morality corresponding to one of the earlier, more primitive stages of moral development, while men more often showed a moral reasoning in accordance with the highest state.

Gilligan did not accept this suggestion of the moral inferiority of women. She supported the finding of the differences, but she did not describe the kind of morality which was found more among women, as an uncompleted proces towards a higher form of morality. Instead, she considered it in its own right. She (as well as later feminist authors) thus not only described what it was not, but also described in positive terms what *did* happen in this 'female' pattern. This 'female' morality was named by Gilligan 'the ethic of care'[4].

It must first be concluded that the ethic of care is not strictly defined by Gilligan, and that there is some variation in what later authors have accentuated. However, in recent publications, there are three consistent qualifications of the ethic of care, which can be directly derived from Gilligan's work (see for something close to a definition Gilligan 1982: 1982). I consider these useful because they characterize an ideal-typically constructed contrast between an 'ethic of care' and an 'ethic of rights'.

The qualifications, which I will work out below, are: 1. contextuality or the absence of a universal set of principles, 2. activity, and 3. responsibility and relationships.

1. One of the most characteristic aspects of the ethic of care can be described by the term *contextuality*. This means that the ethical decision of 'what is right' is, in the ethic of care, based on a considerations of the specific instance under question in its specific context. This can be contrasted with an ethic of rights, where ethical stances are deduced from general, always valid, context-free principles. Others, if they figure at all in the reasoning, are abstract, 'generalized' others, rather than the 'concrete others' in their concrete circumstances which are at the basis of the ethic of care.

This difference can be illustrated with the famous example out of the work of Kohlberg and Gilligan, the question whether Heinz should steal a drug to save the life of his wife. In the ethic of rights, this question would be resolved by a reference to general principles or laws and their hierarchy. There could for example be reference to a principle that one should save a life whenever possible, and that this is a higher principle than 'one should not steal' (Gilligan 1982: 27).

In the ethic of care, one characteristic point is that the question 'should Heinz steal the drug' can in fact not even be answered in an abstract general and hypothetical way. The first thing that is needed is more information on the specifics of the situation. For example: how poor is Heinz. How rich is the druggist. Can't Heinz borrow the money. Why is there no free healthcare available. These are all part of the context, which is essential to come to an ethical judgement. An ethics of rights might disapprove of such a method, reasoning that it would lead to arbitrary judgments where, for example, Heinz would be allowed to steal the drug, where Jones would not. However, for the ethics of care the full consideration of the *specific* contextuality is essential, since it is exactly the specifics, for example the differences between the contexts of Jones and Heinz, that determine what is just.

2. The ethic of care thus consists more of a way of dealing with dilemma's, instead of trying to provide a set of answers to them. As Tronto formulates it, '...this morality is best expressed not as a set of principles but as an *activity*, the "activity of care".' (Tronto 1987: 648). What the ethical outcomes will be, can never be settled once and for all, no matter how subtle and wise the reasoning used.

3. It has also been stressed (f.e. Bayer 1987: 46) that the foundation of this caring activity is a vision of oneself as part of a web of relationships, and responsibility towards the others in this web. Relationships and responsibility are the moral terms which are central in the ethic of care. Relationships are of value and are to be protected. The ethic of care 'evolves around a central insight, that self and other are interdependent' (Gilligan 1982: 74, 127). In the example of Heinz, we see this in the following way. In the case of what Gilligan uses to illustrate the ethic of care, the conviction is demonstrated that, if only Heinz and the druggist would talk to each other and explain their situations, the problem would be resolved.

The Poco-procedure in theory

I will now try to use these main aspects of the feminist vision of an ethic of care to analyze the characteristics and the history of a procedure for dealing with ethical conflicts around university research. This Poco-procedure was developed in 1982 in order to deal with politically controversial research at the university, for example military research. Described shortly, the procedure is initiated when someone brings up a research project as politically controversial.This initiator, and the persons whose research is under discussion, now put together a discussion-committee. This committee will consist of two people brought in by each of the two groups respectively, and a chairperson who is agreed upon by those two people. The committee collects all arguments pertaining to the case and must in any case hear both parties and organise a public hearing.

In my opinion, the 1982 Poco-procedure is a procedure which provides a form for an ethic of care in the context of technology development.

Its first striking characteristic is that the procedure does not define what controversial research is. Instead, it is stated that research is controversial when one person in the university community considers it as such. Thus, rather than providing a set of a-priori formulated principles, this formulation leaves room for a highly contextual use of the procedure. Whether it will be applied to a certain kind of research can be decided freely at any point in time, depending on the judgement of people in their particular contexts.

Thus, it is possible that a certain kind of research project that has been going on for many years without anyone questioning it, at one point in time comes to be seen as controversial. This can be a consequence of new knowledge or possibilities around the technology involved, of new attitudes about controversiality or about the role of universities, of changes in the university population, or possibly of a new social context in which the same research project is embedded. In deciding whether a research project is eligible for being subjected to the procedure, it is not necessary to try to fit it into pre-designed categories. Once a research project has been perceived as controversial by a member of the university community, the procedure has automatically started.

The procedure retains its openness to contextuality as it goes on. There is no attempt to formulate overall criteria or sharply distinguish cases ahead of time and formulate rules as to which research is acceptable, which not.

Rather, a caring activity is required, the contents of which must be established anew in each new context.

In the accent on *activity*, rather than on specifying content-related rules or criteria, the flavour of an ethic of care is again recognizable. The proces of discussing, considering, thinking, and informing is all that is provided in the procedure. There is no mention at all of anything pertaining to *content*. For example, no indication of the agenda of the discussion is given; the agenda will be set by the actors in the particular instance. Thus, the procedure allows that for example, in one case only military implications of research might be discussed, while at another instance the discussion might include a weighing of financial costs and social benefits of the research. There is also no mention of criteria: even the word military is not used to indicate beforehand the kind of research which is to be considered as undesirable. Yet, the *form* of the activity is specified. The procedure, short as it is, prescribes 1. how the committee is to be formed, 2. that 'all arguments' pro and con are to be collected, 3. that the committee should at least consult the two parties and 4. organize a public hearing for whoever is interested, 5. that external experts and opinions will be considered where necessary. Thus, all benefit is expected from information and discussion, and especially from the public and the broad character (*all* arguments, *all* those interested, and the reminder not to forget *external* opinions and expertise) of the discussions.

The third aspect of the ethic of care is also well visible. The procedure is based on the activities of *interaction* and communication. Exchange of ideas is the method that must lead to the resolution of the ethical dilemma. It is explicitly stated that there is no formal regulation of the decision making around the case: no delegation of power nor a special role for the existing powerbases. Implicitly, the trust and the willingness to interact is presupposed. Thus the procedure seems to imply something like a concept of community or relatedness. The 'central insight, that self and other are interdependent' seems to be the basis of the procedure, and at the same time is presumed to be adhered to by the university community for whom the procedure is meant.

The Poco-procedure in practice

In 1988, six years after its completion, the first attempt was made to use the Poco-procedure. A research group, working on high-energy lasers, was planning to enter into a contract with an industry for uranium enrichment. The aim was to apply the laser technology for the enrichment of uranium. Some people in the university community feared that such a technology could be used for the production of nuclear weapons, and started the procedure.

Rather than solve an ethical dilemma, this has lead to a number of problems and conflicts. The research group never appointed someone to participate in the committee, thus in fact never stepped into the procedure. Neither the board of the physics department, nor the university parliament succeeded in changing this. The board of the university voiced the concern that the procedure would be an interference with the freedom of research and signed the contracts without the procedure having been run.

The failure of the first attempt at a Poco-procedure has been evaluated by a committee of the university parliament, called the Evaluation and Revision Committee (Commissie Evaluatie en Herziening Poko-Procedure 1989). Upon reading their analysis, it appears to me that part of this failure can be understood in terms of the difficulties of using an ethic of care in a context where one is more used or open to an ethic of rights.

First of all, it seems that the *contexuality of the initiation* of the procedure was not well understood, or not agreed with. For example, it was argued by opponents of starting the Poco-procedure, that the research under question had already been going on for years. Nothing in the research had changed (Commissie Evaluatie en Herziening Poko-Procedure 1989: 4). Implied was that it would not be just to question something now, which was not questioned earlier. The other side argued that indeed the research was going to be different. However, in arguing this way both sides implicitly base themselves on an ethic of context-free consistency. As I illustrated before, this is not what the Poco-procedure is based on. Indeed, by starting up the procedure, use was made of its contexuality. In this case, it was probably the changes in the social context of the research that triggered the interpretation of it as controversial. Whether or not the content of the research changed, it had become different research because of its embeddment in a cooperation with a multinational firm working on nuclear enrichment.

Secondly, the conception of ***relationships and responsibility*** was not shared by the actors involved. From the beginning, the idea of a mutual problem, to be resolved by an activity of careful communication, was absent. Instead, there was the perception that there were two camps. Wanting the Poco-procedure was perceived as wanting to stop the research. The director of the university-board argued that a discussion as initiated by Poco could only become a 'discussion between faiths', and that the parties would get no closer. According to the evaluation, one participant complained: 'I thought we were all one community', thereby voicing a longing for a situation where a sense of connectedness is present. This person realized that the failure of the Poco-procedure was due to the absence of connectedness.

The evaluative report also states that the procedure did fit the 1982 situation, 'when the university was relatively small and close-knit'. They note how, since then, several factors have 'decreased the unity and the connectedness'. It is not clear if indeed the situation was more open to an ethic of care seven years ago. The procedure was only developed, and not used in 1982. However, it seems clear from this experience, that a procedure for an ethic of care is vulnerable to situations where the connectedness on which it is founded is not experienced by the actors. I would argue that such a situation is a serious problem for any ethic of care. The Poco-procedure unfortunately did not deal with this possibility.[5]

Poco revised

The Evaluation and Revision Committee then suggests a number of changes in the procedure. One thing is the addition of the rule that, before 'applying' for the procedure, the applicant must have talked to the concerned research group. Seen from the viewpoint I'm using here, this can be interpreted as an attempt to improve preconditions for an ethic of care, namely the sense of relatedness and mutual interdependence. Indeed, in the 1989 attempt to use the Poco-procedure, such a prior conversation might have made a large difference. The lack of it was, in any case, one of the main grievances of the research group, which according to them caused their refusal to cooperate.

However, this improvement seems rather an isolated, straightforward reaction to this complaint, rather than that it reflects a revision in line with the ethic of care-character of the original Poco-procedure. For this remnant of the ethic of care is neutralized by a number of other suggestions, which can only be seen as a return to an ethic of rights. The main drift of those suggestions is to localize the procedure closer to the official canals of power. The suggestion is to have the Poco-committee now formed by three people appointed by, respectively, the University Parliament, the University Board, and the Board of Deans. The committee's task is, first of all to see if the application for a Poco-procedure is to be accepted. If so, they must research the issue and report their findings confidentially to the university parliament. This is the whole of the suggested new Poco-procedure.

It is noteworthy that in the revised Poco-procedure, the ethical decision is completely delegated to an administrative committee. Instead of stimulating communication of a public nature and encouraging the participation of the university community in a broad interaction, interaction has been minimalized. Even the 'applicant' of the procedure and the group whose research is concerned no longer get a role in the deliberation. The idea that Heinz and the druggist might resolve an ethical dilemma by explaining their viewpoints to each other has been abandoned.

Also, the contextuality of starting up the procedure has been hampered, by explicitly asking the committee to judge the eligibility of the application. This sets a quite different scene from the original rule, which amounts to that 'a case arises "by definition"' whenever someone feels that there is a case. Thus, the revisions which have been suggested now, after Poco's first failed attempt, unknowingly give up a barely-tried way of integrating a contextual and activity-oriented ethic of care into technology production. They seems to mean a return to the more dominant form of ethics, the ethic of rights.

Thus, to come back to the general question of this paper, we can conclude that the use of the ideal-typical contrast between an ethic of care and an ethic of justice has highlighted some aspects of the Poco-procedure which might otherwise have remained less visible. For one, it suggests that the proposed revisions are not minor alterations, but mean an important change in the character of the Poco-procedure. Secondly, it has analyzed the failure of the use of the procedure, and related this to a lack of a sense of relatedness. This has also suggested the more general point that the ethic of care is dependent on a vision of self and society which is not always generally present. The original Poco-procedure did not provide a means to stimulate such an attitude. It also did not suggest a way in which the ethic of care might still be exercised, even if some of the actors do not adhere to its moral terms. These two questions should be seriously thought about, if we want to keep a Poco-procedure which retains its character. It is not said that measures might not be possible, which would make an ethic of care work in a situation where relatedness would not be ordinarily part of the definition of one's world. However, to develop these, we would first need a commitment to such an ethic. This in its turn presupposes the recognition of the existence of an ideal-typical contrast between the two kinds of ethics.

Thus this paper concludes that, while rejecting the use of feminism as a short-cut way to humanism, feminism used as a 'Vital Inspiration' can have implications for broader issues.

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NOTES

1. distilled from discussions based on, mainly, work done by Gilligan

2. It derives its name from this term 'POlitically COntroversial research'.

3. The idea that there is a 'real' and positive female behaviour and a negative, man-made femininity seems to me fruitless, when the first is meant in an essentialist way.

4. It should be noted that Gilligan denies that she considers the ethic of care something exclusively for or from women, although she is not completely clear on this point. (Komter p.20) Some of the later authors on the topic more clearly reject coupling the contrast of the ethic of care versus the ethic of justice, to men and women respectively. I support this uncoupling, since, as I said in earlier paragraphs, the Vital fallacy standpoint means that the usefulness of the two ethical ideal types is not dependent on their division over the sexes.

5. It is interesting to note that the procedure includes an elaboration of the need to protect the position of the initiator of the procedure and the 'atmosphere'. For the protection of the initiator, some provisions are made. For the protection of the atmosphere, apparently no concrete measures were thought up. Thus this social problem, which, from the standpoint of an ethic of care needs to be dealt with, was recognized and indeed (partly) dealt with, while the possibility of an absence of unwillingness to communicate was not.

A Pregnant Couple? Reflections On Gender Character Of In Vitro Fertilization.

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Recent explosive developments in the field of reproductive technology place the issue of reproduction once again on the feminist agenda. Questions of women's autonomy and her freedom of choice vice versa male dominated medical control over her reproductive capacity, of the role of the state in regulating access to that technology and in defining motherhood, as well as changing views on "responsible motherhood" are heatedly debated. The debate is certainly not confined to feminist circles only. In the Netherlands and elswhere, several policy making institutions are in the process of developing proposals to accomodate In Vitro Fertilization and Embryo Transfer (IVF/ET) technology to the current health care and legal systems. Reading through one of the recent reports concerning the medical and budgetary consequences of incorporating IVF into national health care system, I was struck by a totally new and at first glance incomprehensive statement, namely:

> " On September the 1st, 1988 (...) 107 couples were (...) still pregnant."
> (Ziekenfondsraad, 1989, p.16, underlining mine, M.K.)

At first, I thought it was only a slip of the pen. But re-reading of some medical texts and policy developing reports revealed that a "pregnant couple" is a "logical" consequence of the way in which the problems of infertility are being approached and technically resolved. I realized as well that questions concerning the gender character of In Vitro Fertilization and Embryo Transfer (IVF/ET) and the impact of that technology on the new social constructions around fertility and pregnancy remain largely unaddressed in the current feminist debate. In this paper I am addressing both these questions. In the first place, I analyse those features of IVF which, in my opinion, provide the key to the understanding of the mode in which gender finds its reflection in this technology. My attempt is inspired by the general feminist insights into the relations between gender and science and technology. Secondly, I try to substantiate my claim that this gendered technology neatly fits into the current medical way of thinking about the problems of infertility. Finally , I will argue that the observed shift of attention from infertile women to infertile couples provides a new "scientific" basis for enforcing the subordination of women in the sphere of procreation.

If the pioneers of In Vitro Fertilization are to be believed, the compassion with women who could not have babies, due to blocked fallopian tubes, was the main motivation for the development of this technology. Tubal occlusions make the passage of a mature eggcell down the oviducts, the meeting of the sperm with the egg, and the transport of the eventually fertilized egg to the womb impossible. At the first glance IVF appears as a 'by-pass' procedure for not properly functioning tubes: some of the functions of the tubes, namely providing a place for the fertilization of the egg and the transport of the fertilized egg are substituted by the laboratory manipulations of the gamets outside the woman's body. The development of this 'by-pass' procedure, however, would not be possible without the previous conceptualization of reproduction as a physiological process consisting of causally related events and without the assumption that each of these events can be influenced independently. Such conceptual reduction of the procreation to bodily functions only and the dissection of the whole process into a sequence of relatively self-contained phases is well rooted in current scientific thought, where the reduction and the isolation of the studied phenomena from a larger whole lies at the core of the scientific method. (The feminist critics of science and technology are to be credited for providing us with the valuable insights concerning the intricate relation between masculinity and the dominant scientific practice.) It can be successfully argued that the development of the traditional fertility treatments for women, such as the hormonal stimulation of the ovulation or tubal surgery, would not be possible without this type of conceptualization. But, whereas all the pre-IVF fertility treatments aimed at the restoration of the deficient bodily functions, IVF introduces a new 'paradigm' into the treatment of infertility. It provides a technological replacement of some bodily functions and brings into practice the conceptual dissection of the continuity in the female process of procreation.

The very term of the IVF-technology suggests that it applies to the moment of fertilization only. It suggests that the mature eggcell (ready for fertilization) is taken out of the women's ovary, brought under laboratory conditions into contact with the sperm and subsequently placed into the womb. Nothing is less true, however. In fact, the entire process of female procreation is being affected and subordinated to the laboratory standards for the "successful" fertilization. Let us begin with the "extraction of the mature eggcell". During the monthly cycle of a fertile woman, usually only one eggcell matures and may eventually become fertilized. For IVF purposes the egg has to be extracted from the ovaries before it is released from the follicle. Otherwise, it will be impossible to localize it in the woman's body. It means that the extracted eggcell is not fully matured and that, consequently, maturation has to be imitated under laboratory conditions. Not every attempt to extract an eggcell and certainly not every attempt to fertilize it in a Petri dish is successful. To increase the chances, women are given a hormone 'cure' which often results in a multiple growth of the follicles. This allows the extraction of numerous eggs (up to 20!) in one attempt. To the extracted and artificially matured eggs which are placed in an artificial medium, a reduced number of specially treated spermcells is added. If the fertilization occurs, the fertilized eggs are allowed to divide in the laboratory and two or three days later are placed into the woman's womb. The womb of the woman, whose reproductive system is being manipulated, is not always in the right condition to accept the embryo. So again, hormonal medication is prescribed in order to increase the probability that the embryo will attach itself to the wall of the uterus. The transfer of one or more embryo's from the laboratory into a woman's womb ends the extracorporal manipulation of the reproduction but not the technological interference and control. The question that now arrises is whether and when the woman in whose womb an embryo has been placed is pregnant. And it is not longer a matter of simply yes or not. The technology brings also here a significant change. Depending upon the types of tests and the timing of their application the medical profession is able to record different types of pregnancy. So, a woman may be pregnant chemically and biochemically. She may also experience a commencing, a clinical, an ongoing, a continuing or even a viable pregnancy, though her overall chance of giving birth to an alive baby is not higher than 10%.

It is surprising that the intensive involvement of the medico-scientific staff in the manipulation of the ovulation, egg extraction, creation of embryo's and their placement in the uterus, suddenly disappears, once the direct results of these interventions , i.e. one of the forms of pregnancy or the absence of it becomes known. The eventual birth of a child seems to have more publicity than medical value. These, in relation to the number of treated women, unfrequent events provide the medical staff with the necessary justification for carrying on the IVF procedure.

One of my reasons for looking so closely at what is actually happening during the IVF procedure is to show that it involves the separate manipulation of most of the phases in the female procreation. Each of these manipulations introduces new risks and uncertainties into the process. A woman who undergoes the procedure is uncertain whether the hormonal treatment will result in the multiple maturation of the follicles or will lead to the hyperstimulation of the overies, whether the eggs can be extraced from her ovaries, will they fertilize, will the embryo grow, will the placement of the embryo succeed, will pregnancy develop? The procedure can fail during each of these steps and the medical staff will decide for her when it should be discontinued. This practical dissection of the continuity in the procreation of a woman and its submission to technology is not merely reflected , but rather strengthened by the language used in the medical literature. Women who are the most important actors in the IVF-drama hardly ever appear, and when they do so, then usually under a disguise of a passive patient. (I will return to the problem of who is a patient in the IVF procedure, later in this paper.) More frequently they are substituted by their organs and functions, by the phases in the process of procreation and by techological manipulations. To all these substitutes of women independent abilities are ascribed. The praise of the superiority of the technologically controlled reproduction is sometimes hardly disguised. And the pregnancies are presented as the achievement of the medical staff. The following quotations are quite illustrative for the current representations of the parts of the IVF procedure (all emphasis mine, M.K.).

> "A well-timed interaction of hormones is essential for the maturation of an oocyte capable of being fertilized, as well for implantation success of the early embryo and the first critical phase following conception." (Fischer, R. e.a., 1986, p.56)

> "Variability in the temporal relationships between the oestradiol peak of the periovulatory interval and the detection of the onset of the LH surge caused problems related to timing aspiration of the dominant follicle. This made the natural cycle inferior to the treated cycle from the standpoint of efficient management;(...) Methods to promote multiple follicular development have proven superior to the natural cycle not only in terms of increased oocyte yield, but also by allowing more controlled protocols for ovarian stimulation. This control, achieved by administration of exogenous agents that override the natural cycle, has resulted in increased pregnancy rates in in vitro fertilisation programs worldwide." (Uem, J.F.H.M., van e.a., 1986, p.36.)

> "The first pregnancy achieved by in vitro fertilisation in Australia occurs in 1979. Eight units (clinics, M.K.) with pregnancies completed before the end of 1983 ..." (Australian In Vitro Fertilisation Collaborative Group, 1985, p.592.)

The extraction of the eggcells from women's bodies is frequently called "harvesting of eggs" and the introduction of the ultrasound method is praised not only because it is less demanding from women, but also because it "was a very elegant and simplified approach which could be used repetitively". (Wikland, M., e.a., 1986, p.59.)

Though IVF fails in nine out of ten women treated, questions concerning the adequacy of this procedure for the sollution of the problem are hardely ever raised in the medical circles. To the contrary, the blame for failing to become pregnant is subtly put at the door of women: they do not respond adequately to the 'therapy'. In fact it is even not women who do not respond, but their organs. To the lucky few who do get pregnant, pregnancy presents itself as a technological and medico-scientific achievement. It is not very surprising considering the way in which the IVF-practicionioners present every pregnancy to the public. Usually, women are not mentioned at all, it is only the achievement of the number of pregnancies that counts.

Next to the conceptual and practical dissection of the process of female reproduction two other related features of the IVF urgently ask for a feminist reflection. These are: decontextualization and the focus on interaction between sperm and eggcell.

Until twelve years ago procreation separated from the context of the woman's body could only be imagined in science fiction. The advance of the IVF-technology changed this situation radically. New technological possibilities are deeply affecting the thinking and practice of procreation. Though the experience of millions of women tells us that when you expect a baby you do it with your whole personality, the IVF technology places pregnancy firmly in the uterus only. From this technological perspective the context of the rest of the woman's body and of her mind becomes largely irrelevant. Once the primacy of the uterus is established and the means for removing conception from the body are available, the whole spectre of substitutes is opened. Not only is the laboratory a good substitute for a woman's body, but her eggcells can be substituted by those of other women, and embryo's created from her cells can be placed in any uterus that scientists consider suitable for the development of the foetus. The growing body of feminist literature evaluating the application of the IVF procedure to cases of "surrogate motherhood", the introduction and ready acceptance in daily language of notions as 'surrogate', 'genetic' and 'biological' motherhood, substantiates the claim that IVF cannot be merely seen as a technological blessing for women. Medical technologists are tirelessly looking for new contexts in which the IVF technology could be applied. Attempts to grow human embryo's in animals were made already before the first human IVF pregnancy became a fact. (Wood, C. & Westmore, A., 1983.) Recently, a group of Italian scientists at the University of Bologna, led by Dr. Carlo Bulletti, reported a "successful" experiment aimed at creating a pregnancy outside a woman's body. In the experiment a womb was removed from a woman's body and kept perfused in the laboratory. Then three embryo's were placed into the womb. When the scientists examined the womb 52 hours later, they found that one of the embryos became implanted and showed signs of rapid development. This was considered a sign for the occurence of an early pregnancy (Ob. Gyn. News. 1988). At the other end of the world, Dr. Paul Gerber, a reader in medico-legal studies at the University of Queensland (Australia), proposed that brain-dead women could be used as 'surrogate' mothers. He argued that brain dead people are already being kept 'alive' as sources for organ transplants, so there are no reasons "why a woman's womb should not be used as well". (Corea, G., e.a., 1989, p.161.) It should be clear by now that the key to all these new "applications" lies in the deeply gendered character of the IVF technology, which decontextualises the reproductive process of a woman, not that of a men.

So far, I have concentrated on the impact of the IVF technology on the women's procreative process. Now I would like to call briefly the attention to another aspect of IVF, namely its focus on the interaction between sperm and eggcell. It is beyond any doubt that the fertilization of the eggcell and the subsequent growth of the embryo occupy a central place in IVF technology. Towards this end the reproductive system of the woman is manipulated and the sperm of the man is capacitated. The concentration on the process of fertilization occurs parallel to developments in the field of embryology, where the attention is shifting to the genetic aspects of development. (For the very inspiring analysis of the changes in the field of the developmental biology, see Fausto-Sterling, 1989). Both developments provide a very strong, though false, suggestion of the equality between men and women in their respective contributions to procreation. This false suggestion of equality is, in my oppinion, one of the medico-technological elements on which the recent social construction of a "pregnant couple" is based.

The way from an infertile to a pregnant couple.

In order to understand how the construction of the new phenomenon of a "pregnant couple" is possible in the context of the application of the IVF technology, one has to switch for a while to the problems of definition of infertility and of an infertile patient. As I mentioned earlier, the development of medical therapies for infertility is based on the premise that the inability to have children can be reduced to one or another bodily cause, either in women or in men or in both. This way of thinking is reflected in the use of terms as female and male infertility, in the development of specific diagnostic and therapeutic procedures oriented towards an individual men or women. (This orientation on the individual should not obscure the fact that the majority of these procedures concentrates on the woman as the infertile person.) Even in the cases when the cause of the infertilty cannot be traced to any bodily disfunction it is assumed that such cause does exist. The lack of proper diagnostic techniques is made responsible for the inability to find out the cause.

This individual medical approach to the problems of infertility is, however, contradicted by the conceptualization of infertility as a condition of a heterosexual couple. In the current social setting this rather primitive, though plausible perception can have very negative consequences for women. The initial logic of this approach seems compelling:

> "Fertility is the product of interaction between two people (read a man and a women! M.K.) and so the infertile *patient* is in effect the infertile *couple*."
> (OTA,1988,p.6.)

So far, so good. If infertility is to be defined as a condition of the couple, one would expect the medical science to devise therapies for treating the couple, that is of both partners at more or less the same time. But with the recent development in the field of reproductive technology a radically different interpretation of the 'treatment of infertile couple' comes to the forefront. The diagnosis of infertility in one of the partners can now lead to the treatment of the other, under the disguise of treating a collective patient, an infertile couple. Perhaps it should not surprise us, that women are the treated partner. The necessary technological means for shifting the burden of the treatment

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from infertile men to healthy and fertile women is provided by the IVF procedure. It is given by the fact that for the fertilization of an egg outside the female body much less spermcells are required than under 'natural' conditions. In this manner male infertility, caused by low sperm counts or by the abnormality of the sperm, can be 'treated' by selecting a limited number of the most viable 'normal' looking sperm for fertilization in laboratory conditions. Except for the selection and laboratory preparation of the sperm for fertilization, the whole procedure is performed on women.

Though originally developed as a 'by-pass' procedure for the blocked fallopian tubes, IVF is now being heralded as the only really effective "therapy" for some types of male infertility. At the same time male infertility is redefined as infertility of the couple.

> "In most instances there is no effective therapy for the male with the inadequate sperm. Clearly some males (...) can be helped by the direct resort to IVF."
> "Some couples with sperm counts which are clearly inadequate to provide for fertilisation in the normal female reproductive tract can be helped by IVF." (Jones, Jr., Howard W., 1986, respectively p.17 and p.25.)

The commitment of scientists to help of the infertile seems to be endless. Recently successfull experiments have been reported with the microsurgical injection of a single spermatozoa into a cytoplasm of the human egg. (Corea, G., 1989, p.144) Once the knowledge derived from this kind of experiments will become operational, the way will be opened for submitting women to the IVF procedure in order to 'treat' practically hopeless cases of male infertility. Or, as the influential Office for Thechnology Assessment has stated:

> "Successful pregnancies following micromanipulation of a single sperm into an egg (...) would mark dramatic progress in the treatment of male infertility, most of which is caused by too few or abnormal sperm." (OTA, 1988, p.14.)

In the first part of my paper I argued that the IVF technology leads to the practical dissection and decontextualization of the female procreation. The extraction of the process of fertilization from its natural context, the female body, and its reduction to the interaction between egg and sperm cells contributes to the progressing depreciation of women in the technologically restructured process of procreation. The application of IVF as a 'therapy' for male infertility results in the decontextualization of the technology itself. Developed to help women with blocked fallopian tubes, IVF is now also performed on fertile women in order to resolve the infertility of their partners. This originally 'unintended' (?) application of IVF reflects the current unequalities between the sexes in the sphere of reproduction. On the other hand, IVF provides the technological means for the reinforcement of the subordination of women to the interests of men. This technology plays an important role in the current process of blurring the borders between an individual and a couple. The power dimensions of this process become clear as well. Though male and female infertility are being redefined as the infertility of a couple, the treatment of an infertile couple always means submitting the woman, not the man, to the medical procedure. Independently of the question whether or not the cause of infertility can be traced to the woman.

Within this new conceptual framework, the appearance of the 'pregnant couple' is by all means logical. The couple suffers from infertilily, the couple is being treated for infertility, and when the laboratory fertilization of an egg by sperm and the embryo transfer are successfully performed, and pregnancy achieved, the couple becomes pregnant. And so the old story of science, technology and women is being repeated, and again women are not there. Not even as objects!

Enschede, 20.01.1990.

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THE DOUBLE DILEMMA IN THE SCIENCE EDUCATION OF GIRLS IN DEVELOPING COUNTRIES: A CASE STUDY OF SCHOOLS IN RURAL SIERRA LEONE

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SUMMARY

The double dilemma in the science education of girls in third world countries constitutes two "push" factors which repel girls from science. These are socio-cultural factors, and the unfavourable conditions for science education created by the general economic malaise in those countries. Although the latter dilemma affects both boys and girls, it presents an additional barrier for girls.

This paper attempts to discuss the components of the second dilemma as seen in a case study of two schools in rural Sierra Leone. The findings reveal a dire state of science education in the schools particularly the dearth of science teaching materials, and the need to boost up teacher motivation and effectiveness through in-service programmes.

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INTRODUCTION:

There is now ample evidence in the literature to show that socio-cultural factors do present a barrier to the science education of girls and their subsequent taking up of scientific careers.

The differential expectation of teachers and parents of the achievement of girls, the unequal treatment of boys and girls in science classes, sexist illustrations and references in curricular materials, etc. all work in subtle ways to shape the negative self-image of girls about their own abilities in science.

The literature abounds with revealing and disturbing evidence of these issues. For instance Spear (1987) in studying the biasing influence of pupils sex in a science marking exercise proved that work attributed to a boy was rated higher than identical work attributed to a girl. Crossman (1987) confirmed that science teachers in general interact more with boys than with girls. Kelly (1987) discussed the re-contextualization of gender where boys assert their masculine characteristics, surpress the girls, and dominate science classes.

Among the intervention strategies and programmes suggested and tried are, the Girls Into Science and Technology (GIST) project of the U.K. (Kelly et al 1987), a girl-friendly science curriculum (Smail 1987), using indogenous technology to teach science concepts (Amara 1987).

For girls in third-world countries these socio-cultural barriers constitute the first dilemma. The second dilemma is found in the poor conditions and facilities for proper science education, created by the general economic malaise in these countries.

An attractive and stimulating learning environment coupled with positive teacher attributes are bound to have a powerful force in attracting girls to science. Case studies of secondary teachers on the retention of girls in science reported by Kahle (1985) revealed that teachers who were identified as successful with girls in science were not only fair in their treatment and expectation of both boys and girls, but were also exemplary teachers who maintained well equipped and stimulating learning environments. Their classrooms were found to be filled with posters, pictures, models, live specimens, and a variety of textbooks.They emphasised laboratory-based science teaching, students projects and library research, televised instruction, field trips, the use of Audio-visual equipments and other science materials.

Such learning environments are not common in third-world countries due to economic and moral constraints, which present a barrier for the proper teaching of science. Although this second dilemma affects both boys and girls, it presents an additional constraint for girls (i.e. in addition to the socio-cultural influences). This paper attempts to discuss the components of the second dilemma as seen in a case study of two schools in Sierra Leone.

THE CASE STUDY

Two schools, one primary and one secondary were selected for the study. Ten teachers, five from each level were interviewed. The interview schedule was designed to investigate the following:
1. Teacher characteristics. 2. Method of science teaching.
3. Science curriculum materials and equipments used. 4. Problems affecting their work.

It was not possible to observe actual science teaching by the teachers but an inspection of the classrooms to assess the stimulating quality of the learning environment was done.

PRESENTATION AND DISCUSSION OF FINDINGS.

1. Teacher characteristics.

Table 1 summarises the characteristics of the teachers interviewed. Although the majority of them had teaching qualifications, 70% received no special training in the process-based method of teaching science. The teachers were equally deficient in exposure to in-service training. Although 60% had received some in-service training, the programmes were of short duration and far in between. Two of the primary teachers for instance who had taught for 19 and 16 years respectively had received only 30 days exposure and as far back as 1975. The teachers therefore did not only lack professional training in science teaching at the pre-service level but also had inadequate opportunity for professional growth and development while serving.

Table 1: Characteristics of teachers interviewed

	Primary Teachers					Secondary Teachers				
Teacher Characteristics	1	2	3	4	5	1	2	3	4	5
Sex	M	M	M	M	M	F	M	M	M	F
Age (Years)	28	27	42	40	49	24	30	28	29	31
Qualification	Form 5	TC	TC	TC	TC	BSc.	BSc.	BSc	BSc.	HTC
Teach.Experience(Yrs.)	6	4	17	19	16	0.25	3	4	5	9
Special training in process-based teaching	No	No	No	No	No	No	Yes	Yes	Yes	No
In-service training received: duration(days)	1	-	11	30	30	-	-	21	42	-
Year(last training)	1986	-	1987	1975	1975	——	-	1989	1988	-

BSc. - Graduate teachers. Form 5 - Fifth form in Secondary school.
HTC. - Non-graduate with Higher Teachers Certificate.
TC. - Non-graduate with Teachers Certificate

The importance of updating teachers' knowledge and skills cannot be over-emphasized, particularly in an area as dynamic as science. Several writers have identified in-service programmes as a channel for achieving sex-equality in science (Raat 1983; Ferguson 1983). Most of what has been suggested however focus on improving the teachers' attitude and increasing their awareness of the special need of girls in relation to science. In third-world countries where girls are in a double dilemma, there is need for in-service programmes to have a dual focus, and emphasise the problem of girls and science, as well as improving the teachers' professional competence in science teaching.

2. Method of science teaching.

Science has been described as both a body of knowledge (recorded facts) and a process (systematic observation, investigation, data collection, analysis and interpretation). The method of teaching which enables the learner to experience the process part of science has been described as the process-based method. The interviewees were presented with the above definitions and asked to indicate how much they use the process-based method in their teaching.

It was revealed that only 10% of the teachers regularly used the method, 70% used it only occassionally and 20% did not use it at all. Reasons given for not using this method were, among others, lack of materials and the time consuming nature of the method.

By implication therefore the method that is used regularly by most of the teachers is the traditional lecture method where facts are given out to the learner. This is understandable considering their lack of training in the use of this method and the rigid examination system which makes "covering the syllabus" their first priority.

Although science teaching through the process-based approach is complex and time consuming, it has lasting values which make it the most suitable method to use particularly at the primary level. It does not only develop skills and knowledge but most importantly, it helps the development of positive attitudes towards science. According to Harlen (1987) attitude to science seems to be formed earlier than to most other subjects and children tend to have taken definite positions with regard to their liking of subjects by the age of 11 or 1[illegible]. Simpson (1983) echoed this point by asserting that girls are every bit as capable as boys in their approach to scientific experience and that this ability is evident as early as 5-6 years.

Thus if all children in their formative years are made to experience real science (i.e. feeling the excitement and joy of discovery) they are more likely to develop the motivation and interest to continue science at higher levels of their education. This is a sure way of closing the current gap between men and women in science but it cannot be done by the "chalk and talk" method.

3. Materials for science teaching - a case of the naked classrooms

This was the most revealing part of the survey. All the classrooms observed can be described as "naked" except for chairs and desks. There were no science equipments, no A-V aids, no live or dead specimens, no class libraries, no evidence of pupils' projects, no wall charts or pictures. These classrooms present a sharp contrast to those in developed countries as described by Kahle (1985) and mentioned in the introduction of this paper. Although the secondary school observed had a science laboratory, 90% of the teachers assessed it as inadequate in terms of equipments.

Manipulating materials and equipments is an inevitable aspect of processed-based science learning particularly at the primary level. It is not possible for pupils to experience real science without manipulating materials. Of more relevance to girls is the suggestion that the lack of spatial ability (one of the reasons given for girls' inability to do the physical sciences) can be improved by providing opportunities for pupils to manipulate mechanical toys and construction kits (Simpson 1985). It is impossible to achieve this in "naked" classrooms. The dearth of up-to-date reading materials in the schools was another disturbing reality. All the secondary teachers reported that the only books available were those prescribed by the school and appropriate for the National Examination (The General Certificate of Education(GCE). Both teachers and pupils have to buy personal copies at prohibitive costs because the books are imported. Most pupils cannot meet the cost of the books and they have to rely on the teachers notes. The government has however initiated a text-book project which aims at solving this problem.

The situation is the same at the primary level where the Sierra Leone Primary Science Texts supplied free by the Ministry of Education are the only reading materials available for both teachers and pupils. The pupils are expected to share the books(about three to one) and are not allowed to take them home.

There were no supplementary reading materials for teachers and pupils at both levels. Although the secondary school had a library, it was assessed by the majority of teachers as inadequate and lacking in useful current texts. The primary school had no library at all.

Another aspect of the second dilemma is that all-girls' schools are more disadvantaged than all-boys' schools in terms of facilities for science teaching. Of the 16 girls schools in the country only one is qualified to operate sixth form science (as compared to the large number of sixth form science schools for boys). This is due to the shortage of materials and qualified teachers in the girls' schools.

4. Problems affecting the work of teachers

The interviewees were asked to rank order 12 problems according to difficulty. The results revealed that both primary and secondary teachers have similar problems. The problems which were put in the first three ranks by 80% of the primary teachers and 60% of the secondary teachers were: irregular salaries, shortage of science texts and equipments, and inadequate library and laboratory facilities. Irregular salaries being one of the most difficult problems for teachers has serious implications for teacher motivation and effectiveness in general, but more so for science teaching which demands extra time and energy from the teacher.

CONCLUSION

For women to achieve equality in science, the obstacles posed by the second dilemma must be redressed urgently.

Some good intervention strategies have been suggested to redress the first dilemma (i.e. socio-cultural influences) as mentioned in the introduction of this paper. However it would appear as if these strategies are suggested with the assumptions that: 1 Facilities for science teaching and learning are adequate. 2 The learning environment is rich and stimulating. 3 There is an adequate supply of suitably qualified science teachers. 4 All teachers are sufficiently committed to spend the extra time and energy required for proper science teaching.

These are erroneous assumptions to make in third-world countries as revealed by this case study. A quick move should therefore be made to design and implement intervention programmes to redress the second dilemma. Such programmes should aim at giving an overall "face lift" to science education in third-world countries particularly in Africa. Since the problem of girls and science in these countries are graver than in developed countries(because of the double dilemma) concerted inter-governmental effort at least at regional levels is needed in implementing intervention programmes.

The African Primary Science Programme (APSP) and its successor the Science Education Programme for Africa (SEPA) were inter-governmental programmes developed in the sixties. These programmes had as a major objective the dissemination of the innovative idea of process-based science teaching. In addition, they were concerned with ensuring equal access to training opportunities for men and women (Kamara 1987). Unfortunately, these programmes which held a lot of promise for science education in Africa are now defunct in Sierra Leone and most likely in other African countries as well. Re-instating these programmes is a good way to start implementing intervention programmes for the second dilemma.

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INNOVATIVE SCIENCE CLASSROOM PRACTICES

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1. Introduction

> ***Science is speculative, creative and absorbing!***
> ***It is a challenging area which involves being curious, taking risks, sharing ideas and caring about the quality of our lives and our world.***
> (Gianello, 1988, 3)

This quote not only sets the scene for the McClintock Collective's first book of activities, but also forms the basis of our enthusiasm for changing the teaching approaches used during science lessons. Science, for us, is a dynamic, exciting pursuit and the Collective has begun to evolve new ways of working with girls which are meeting with wide acceptance in our education community.

The McClintock Collective is a network of science educators, across all levels of education, who are actively working towards creating a **gender inclusive science education.**

> *"A gender inclusive science education* ***incorporates, values and extends:***
> *the prior experiences and learnings; the current interests, needs and concerns; and the preferred learning and assessment styles, of* **both** *girls and boys.*
> *A gender inclusive science education utilises the strengths of all students, (e.g. co-operative work skills); creates space in the structure of the course to close differential gaps in prior experiences (e.g. tinkering with tools and machines); includes activities which reflect the reality of science as it is practised (e.g. speculative, values-led, creative); and provides a curriculum which is not exclusive in its use of language, selection of content, use of resources, entry points, teaching methodologies, and classroom interaction patterns."*
> (Hildebrand, 1989, 16)

Innovative teachers are risk-takers: especially teachers who have a mission to remove social injustices such as those that exist in the area of women and science.

In developing ways to create a learning environment which promotes the access and success of girls in science, we build upon the viewpoints and experiences of teachers who are active in seeking advances in the area. Thus teachers have not been the subjects of research, nor the by-standers of research by others. In the development of these approaches teachers have been partners in the research model, and **teachers are the researchers**.

The manner in which the McClintock Collective initiates, develops and disseminates new approaches is to start with the facilitation of the sharing of ideas amongst teachers. This is done through various forums, such as weekend writing conferences, evening workshops, one or two day in-services, regular monthly meetings, and a journal where teachers' ideas are published. In these forums, possibilities are debated and shaped into classroom activities for subsequent trialling. Depending on the teachers' perceptions of the success of the activity it is either further developed or radically altered. The Collective thus provides an important environment where teachers, who often work in isolation, can have their ideas validated by their colleagues and are further encouraged to explore and continue developing new approaches for teaching girls.

The model used in this development and change process is that of **action research.**

> *"Action research has four phases:* ***planning*** *where a decision is made about the research question and a course of action is planned;* ***acting*** *in which the plans are carried out;* ***observing*** *which concentrates on analysis of the action and* ***reflection*** *where an understanding of the observations is developed and new plans are made."*
>
> (Lewis and Davies, 1988, A-10).

A federal government funded Project of National Significance: the Girls and Mathematics and Science Teaching Project (GAMAST) has extended and clearly documented this process for emulation by others (Lewis and Davies, 1988). Their professional development manual provides instructions for running workshops with teachers which allow teachers themselves to control the speed and direction of change whilst being introduced to gender inclusive teaching ideas. The GAMAST model has become an exemplar of an effective change process, and is now being used in Victoria, through a state government funded project, to ripple its effects outwards to more teachers and hence to more students. Because the researcher-teachers "own" the process they are key stakeholders in its implementation and success.

This short article illustrates a sample of three strategies that are outcomes of our work in Victoria. These have been selected from over forty strategies which have evolved over a period of six years of action research work in primary and secondary schools. As teachers in schools trial and adapt these strategies to the needs of their own students further modifications and ideas are generated. Additional details and examples of these ideas in practice are provided in Gianello (1988), McClintock Collective (1989), Lewis and Davies (1988) and various volumes of the "McClintock Memos" journal.

2. Creative Writing

Common ways of writing in science classes are reporting and explaining, however it is also possible to use a wide variety of other genres. More creative forms of writing include fantasy, futuristic, argumentative, journalistic, comedy, poetic, screenplay, anthropomorphic and conversational genres.

Each of these genre empowers students to be exploratory and speculative while they are engaged in **clarifying thinking through writing.** These forms of writing, usually involve a drafting-talking-editing-rewriting approach. The critical factor is that in a creative writing activity, we encourage students to use their imagination to open, expand and challenge their ideas in order to enhance their conceptual understandings.

For example, anthropomorphic writing is an effective way for students to gain a "feeling for the organism" (Keller, 1983) or other object or process which may be under scutiny in a science lesson. In the anthropomorphic genre students ascribe human characteristics and/or feelings to inanimate or non-human objects, and this facilitates their thinking from a new and often illuminating perspective.

The following tasks are examples of anthropomorphic writing:

> *Write a conversation between two molecules of water in an ice block as they are heated in a kettle from 0°C to 100°C.*

and

> *You are a ball resting after a game. Describe the forces you have just experienced.*

Not all creative writing is anthropomorphic. For example:

> *You are a Travel Agent on Neptune. Write a brochure for earthlings explaining the virtues of your planet.*

and

> *Write a poem about a particular invertebrate, which humorously describes that animal whilst telling of five scientific facts.*

Many examples of similar ideas and student writing can be found in PEP (1987); Gianello (1988), Hildebrand (1989a and 1989b), and in Lewis and Davies (1988).

Creative writing may be placed at the beginning of a topic to assist in the identification of pre-conceptions or to focus on the forthcoming area; during a topic to assist students in their construction of meaning; or at the end of a topic to assess levels of conceptual understanding, application or synthesis. Certainly writing in science should not be a fill-in or homework activity. It is a powerful means of exploring relationships and developing ideas.

3. Drama:

Two ways of using drama in science lessons are: creating human models of scientific ideas, and role-playing people in particular situations.

3.1 Human Models:

Many ideas, objects and processes in science are difficult to understand because we cannot see them with the naked eye, nor directly experience them with any of the other senses. We have found that constructing a working model, by using the students to act out a concept, is an effective way to promote meaningful learning.

When such a **human model** is utilised as a means of thinking through and clarifiying ideas, the physical movement of the body in space, and its relationship to others, enables students to quickly grasp ideas, whilst enjoying themselves at the same time. Long term retention of key principles appears to be an outcome of using participatory drama to explain science in this way.

For example, we use acting out to show students the processes which occur when states of matter change. More complex factors, such as vapour pressure, are built into the drama for senior students to allow for a more sophisticated model. Similarly students can form gear wheels to act out what is happening in an egg-beater or bicycle. Some other examples are: the differences between galvanic and electrolytic cells, series and parallel circuits, and between covalent and ionic bonds.

3.2 Role Play:

In **role play** students can be themselves in another time, place or situation, or they can act out the role of some-one else, such as: Lise Meitner debating nuclear weaponry; a surgeon on a liver transplant committee; or an environmental advisor to a supermarket chain.

The teacher constructs the situation and allows students the freedom to explore scientific, social and ethical issues within that context. For example, the teacher announces that a town meeting will occur this afternoon on the future of the local lake. She distributes role cards to students which state their membership of a community group (e.g. bird-watchers club, town council, trail-bike riders club, etc) and allows time for students to co-operate and prepare their tactics, before setting up the meeting. After the role-play, the teacher de-briefs the students to assist them in their analysis and reflection of the factors which impact on the debate.

Whether the drama activity involves a human model or a role play it can be pre-planned, even scripted, rehearsed and performed for a peer group or a younger class; or it can be a spontaneous group problem solving activity as the need for clarification arises. For further examples see Gooding(1987), Gianello(1988), Hildebrand(1989c), Lewis and Davies(1988) and PEP(1987).

4. Tinkering:

> "*Inability to use and understand simple machines creates a feeling of powerlessness and separateness from physical science and all things technological.*" (Gianello 1988, 65)

To help girls understand the basic principles of machines and how things work, and to help develop their competence and confidence in handling equipment, the McClintock Collective encourages 'tinkering' activities to be included in the science curriculum, both at primary and secondary levels. Tinkering refers broadly to a way of exploring tools, machines and how mechanical things work and is a skill that many boys, but few girls, pick up informally during their childhood years.

Whilst many girls develop fine motor skills connected to fabric construction and design activities, these are not valued by them, nor society, nearly as much as are the spatial abilities and manipulative skills associated with putting together train tracks and glueing together, and flying, aeroplanes! Girls who reach secondary physics classes often find their male peers are far more experienced with taking mechanical things apart, and hence more able to understand and be abstract about physical science concepts. This differential **mechano-tactile** experience also gives boys more confidence with handling equipment.

From our observation girls more frequently seek concrete examples to help them understand physics principles, being unconvinced and frustrated by explanations that are given only in terms of equations. Many schools in Victoria are changing their curriculum to incorporate new resources and learning opportunities to bridge this experiential gap. Three different tinkering activities are described here.

Construction kits, e.g. Lego Technic, are used extensively for open-ended model making and problem-solving design tasks, and for exploring how to make things move. One example of an activity is:

> *Design and build a toy for a four-year-old which turns circular movement into side-to-side and/or up-down movement. e.g. As the wheels under the elephant turn, its head swings.*

Boxes of household, carpentry and other tools are collected to ensure that a wide variety is available, e.g. scissors, hammer, can-opener, chopsticks, soldering iron, cutlery, ruler, pen, toothbrush, drill, tweezers, shovel, etc. Questions such as: "What is it? How does it work? What is it made of? Could I design it to be safer/cheaper? Who uses this at work? What could be used instead?" are used to guide students' work. Following this warm-up, a "Machine Tool Search" (Gianello, 1988, 86) begins by asking students to brainstorm examples of tools and machines, and then to classify them and create a definition that distinguishes between the two terms.

"Junk" appliances (e.g. broken toaster, clock, hair-dryer) collected from 'opportunity shops' are a valuable resource for a third type of tinkering activity. When students dismantle and re-construct an appliance, they also do one, or more, of the following: explore how the functional parts inter-relate; investigate and question the constituent materials; determine the process of construction; and discuss and debate design improvements. An important side benefit for girls is the incidental learning and confidence building that comes about through the selection and use of appropriate tools. (For further details on how specific classes are organised see Dick, 1987 and 1989, Groves, 1987, and the "Tink About It" unit in Gianello, 1988)

Problems can arise in mixed-gender classes however, where the confident approach of experienced boys can overwhelm the fragile enthusiasm of the inexperienced girls. A variety of activities and open ended problems need to be designed to allow for different levels of ability and confidence. Schools are experimenting with single-sex classes as one solution to this, some finding their girls to be less inhibited and more positive about their learning.

5 The Future

The level of awareness about girls and science issues is fairly high. We have moved beyond the policy level and action plans are now established in Victoria. Teachers are demanding specific ideas that will assist them change their classroom environments to cater better for girls, and the Collective's work is highly regarded because of its concern for practical suggestions which grew out of teacher trials. A large number of teachers in Victoria, are trying the sorts of ideas outlined in this paper, along with the many other McClintock Collective strategies. Feedback to date is positive and affirming. Workshops where participants experience and think about gender inclusive learning models are in great demand and the state government is setting up a Girls and Mathematics, Science and Technology Centre this year, which will provide staff and support for the professional development of teachers and for research in this area.

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Concepts and Strategies concerning Information Technology Education for Girls and young Women

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Abstract

Girls are less ready to take part in information technology courses in schools than are boys. There is a long term danger that women may be excluded from skilled work in the field of information and communication technology. How can this gender related behaviour be explained? What concepts and strategies might lead to equality for girls and young women? In the following, two projects are described which are intended to prevent discrimination against girls and young women in the field of information technology:

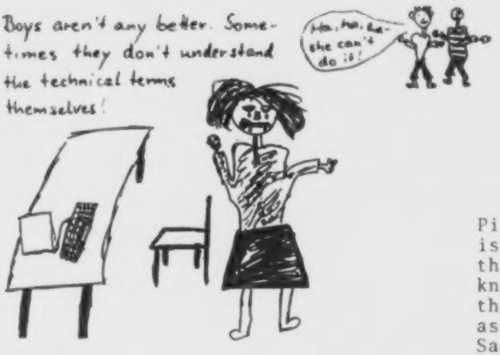
1. A concept of holiday computer courses for girls, which combines information technology with aesthetics.
2. Curriculum recommendations for training in the field of information technology in schools.

How can gender-related differences be explained?

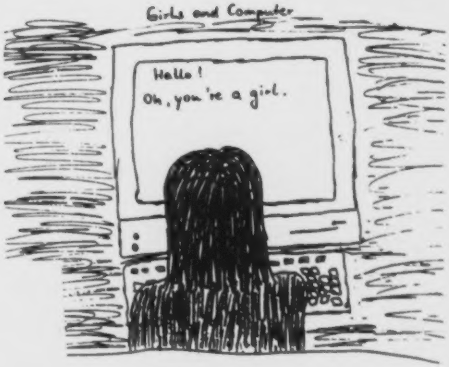
There is a wide consensus of opinion that the attitudes and behaviour of the sexes are influenced by socialisation processes which are in turn determined by social structures, especially by the division of work between the sexes (family - career). A theoretical explanation of gender-related behaviour can be seen in the varied concept of the self. This means all an individual's attitudes, judgements, and value judgements concerning his/her behaviour, abilities and qualities. The self concept involves both the perception of these variables and value judgements made about them. Presumably the preservation of the feeling of self esteem is of fundamental importance both for the development of the personality of the child and for that of the adult (EPSTEIN, 1979). The self estimation and appraisal of girls and boys is dependent on value judgements about the roles of the sexes in our society. As "male" roles with the supposedly male characteristics such as the ability to think independently, behave instrumentally, and act in a technically competent way are estimated as being more important than the "female" role with the qualities of sympathy, emotionality, gentleness, passivity and the readiness to be submissive which are assigned to it, girls have no alternative but to become aware of their disadvantages and learn to estimate them at an early age. An example of this is that while boys and men tend to have a positive feeling of self worth in comparison with other less competent rivals, girls and women consider their ability to be socially sympathetic to be stronger (GILLIGAN, 1984). The development of the identity of girls takes the form of a permanent active conflict between the contradictions of the "femininity" which is required and self respect. Showing oneself to be competent in predominantly male areas - also in the field of information technology, then - would mean leaving the well trodden path to the increasing of self esteem for girls and women.

Female and male peers play an important role as they form an important group where breaking away from parents is concerned. If there is a danger of loss, traditional norms are strictly adhered to: girls look for reassurance and reaffirmation of their identity above all from their male peers. Studies show that young men also cling to sex specific ideas relating to ability in the area of information technology, and that in doing so they make it more difficult for girls to get involved in it - though this may well also be due to the fear of competition (BRANDES/SCHIERSMANN/BRIGITTE, 1986; FAULSTICH-WIELAND, 1986).

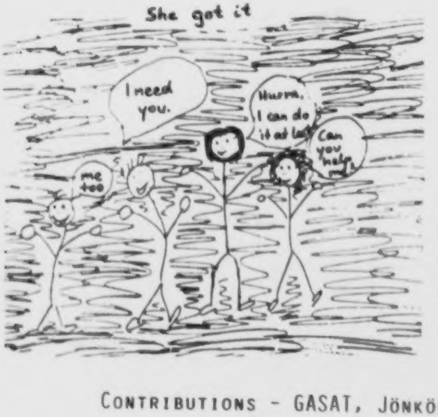
The following drawings done by girls on the theme of "girls and computers" who took part in the computer holiday course are an expression of this conflict as they experienced it. No discussion about what they had experienced took place before the drawings were done, yet they were almost all concerned with the attitudes of the boys to them. The necessity and desire to assert themselves was in the forefront (pictures 1, 2).


Boys aren't any better. Sometimes they don't understand the technical terms themselves!
Ha, ha, ha - she can't do it!

Picture 1: The girl is struggling against the boys' arrogance, knowing well that they often only act as if they know more. Sadness and anger are visible.

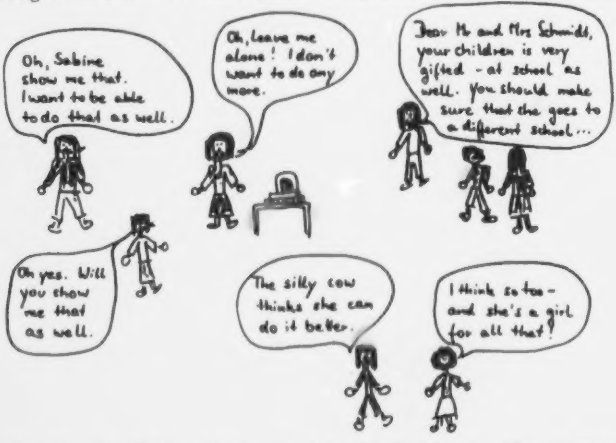

Girls and Computer
Hello! Oh, you're a girl.

Picture 2: The girl shifts the discrimination to an "objective" level, the machine, so that it becomes an unchangeable reality.


She got it
I need you.
Hurra, I can do it at la
Can you help me
me too

Picture 3: Success is a positive experience: The others are happy with the girl that she can handle computers competently and do not put her down. She is the focal point of attention.

At the end of the holiday course the girls were given the opportunity to discover what they thought it would be like to be technically highly skilled by means of an imaginary journey. The story ended with the following idea: "You are a girl who is very good at using computers - boys ask you for advice too ..." At the end they were asked to draw what they had imagined. About half of the girls could enjoy the idea of being successful (picture 3). Other girls felt isolated, left out, emotionally overtaxed and annoyed. In their imagination, behaviour which deviated from traditional roles was "punished" by their female contemporaries; as such it was seen to make excessive demands on them (picture 4). The conflict experienced will vary in degree according to self esteem and self confidence. Female and male educationalists must therefore be ready to support girls and women in overcoming socially determined roles, and in altering their self concepts. Esteem for traditional sexually determined roles can also be found in the attitudes of male and female teachers, however, and affects the interaction between male/female teachers and male/female pupils (cf. FRASCH/WAGNER, 1982; ENDERS-DRAGÄSSER/FUCHS, 1988). This means that both changes in outlook and behaviour must be brought about in female/male teachers and female/male pupils.


Oh, Sabine show me that. I want to be able to do that as well.
Oh, leave me alone! I don't want to do any more.
Dear Mr and Mrs Schmidt, your children is very gifted - at school as well. You should make sure that she goes to a different school ...
Oh yes. Will you show me that as well.
The silly cow thinks she can do it better.
I think so too - and she's a girl for all that!

Picture 4: This girl no longer accepts the successful role. She is not working at the computer. The boy and girl (bottom right) have obviously turned away from her and shut her out. Success is being punished.

What concrete conceptions and recommendations can be made concerning information technological education in the Federal Republic of Germany so that it is suitable for girls and young women?

Curriculum Conference on "Information technology Education for Girls"

Information technology education currently available in schools in the Federal Republic of Germany needs to be thoroughly revised so that girls are given equal access to information technology. For this reason a five day curriculum conference was led by the author on the following questions in 1988:

- "How should information technology education (the basics of information technology, and informatics) be planned in schools so that girls have equal access to it in schools?" and
- "What strategies are recommended so that the realisation of goals, subject matter and methods also leads to actual success?"

The conference started from the assumption that acquiring specialist knowledge in informatics formed the basis for increased self confidence, for an appropriate choice of career, and for the ability of girls and women to influence the use of information technology.

Women with very varied skills were invited to the conference: teachers, programmers, women trained in informatics, women involved in research, unions, industry, adult education, cultural projects and in one branch of the media. The result of this was the production of recommendations for information technology education with four lesson proposals primarily for informatics in grade 11 and 12 and strategies for implementing it. The following were planned:

- a teaching model for the basics of information technology, "Computer and Creativity",
- the concept of an introductory course for informatics,
- an "Expertise and Expert Systems" unit, and

- a project for the use of information technology in the textile business.

Excerpts of the recommendations and strategies which were developed by the female conference participants are reprinted in the following.

Recommendations for Aims, Contents and Methods

Teaching the basics of information technology should not be the exclusive province of a single subject. The concept of the Bund-Länder-Kommission (BLK, 1987) on the teaching of information technology, which is a basis for the Länder, requires the following additions:

- Influence on the formation of systems

The basics of information technology is concerned with user software, not necessarily with the learning of a programme language. As users of user software, female pupils should learn how they can influence the development of software, hardware and the organisation of work.

- Ethical Responsibility

Demystification is necessary for the realistic assessment of the opportunities created by and the limits of information technology. The inscrutability, uncertainty, and fallibility of (network) systems should also be stressed. The ethical responsibility of people and political decisions (which also involves the limitation or removal of information technology in certain areas) must be dealt with in lessons.

- The Use of Computers in the creative Area

The creative use of computers in the area of the plastic arts (graphics), music, literature, also in connexion with sensual perception and the fine arts should be involved in lessons to a greater degree.

- Historical and Philosophical Aspects of the Relationship between Human Beings and the Machine

Lessons should make it possible for female and male pupils to experience the relationship between human beings and technology as a historical and philosophical question. The implications of change must be treated on the one hand from the point of view of the relationship between the sexes, and on the other hand the role of science and technology should be considered where social developments are concerned.

- Formal Thought versus Intuitive Thought

Lessons should make it possible for female and male pupils to get to grips with their relationship to the computer as a machine. In this process sexually different attitudes are thematised; in addition to this a discriminating attitude to formal thought should be created in connexion with this. A sex specific moulding of technology should be reflected.

- The Effects of Information Technology on the Relationship between the Sexes

The effects of information technology on the relationship between the sexes should be made clear as well as its social and economic effects (the employment of women, housework, the representation of men and women in the media in connexion with information technology, the social allocation of roles).

- The Role of Women in the History of Data Processing

In the representation of the development of data processing the role of women in the history of data processing should be made clear.

- Models for Girls and Women

Models should be introduced especially for girls, e.g. qualified women who are successful in typically male professions. In this way they can also include "typical male professions" in their career decisions.

- Holistic Education

In addition to purely cognitive aspects, care must be taken that physical and emotional aspects are allowed to play a role in lessons as part of a holistic concept of education. This should be applied both to social contents and to algorithmic problem solving.

Strategies for the Implementation of Recommendations

Several studies have shown that the coeducational approach does not lead to the equality of girls and to the destruction of undermining sexual stereotypes, this is especially true of mathematical, scientific, and technical teaching. New, more flexible forms of lesson organisation should be tested which take the various different approaches and ways of working of the sexes into consideration. Lessons should be organised in such a way as to enable both a limited, situational division of the sexes and teaching in mixed groups. In each teaching phase it should be considered whether

- specifically female/male interests, ways of working or roles should be encouraged and dealt with in separate groups;
- typically male/female themes should be dealt with by the opposite sex;
- a theme can be dealt with in a mixed group in the same way.

All thoughts about the changing of organisational forms, the content and methods of information technological teaching and the inclusion of girls' interests cannot have any effect if women teachers are not able to understand and implement these considerations. New concepts must be developed especially for in-service training. More women should be allowed to attend inservice training courses and to lead courses themselves. In addition to this, courses for women only should be made available. More courses in the areas of the development of the personality and interaction training should be made available and ways of supervising lessons should be created; the cooperation of female/male movement educationalists, female/male psychologists and others is to be recommended.

Short Term Requirements

- Model experiments and projects should be encouraged in which teaching material is produced and new forms of teaching information technology are tested;
- Women must be given priority where qualifications and in service training are concerned;
- Teacher training and in-service training for women must be changed.

Concept of a Computer Holiday Course for Girls

The proposals referred to at the beginning concerning supporting girls and young women where changing their self concept is concerned, formed the basis for the conception of an extra curricula course. The basic concept was that of combining information technology education with aesthetics. Here aesthetics is seen in the broad sense as a philosophical theory which is concerned with sensual recognition as opposed to conceptual recognition (the abstract conceptualisation of the awareness of the intellect). It aims to preserve and possibly improve sensual recognition on the basis of personal theoretical efforts. Aesthetics means confronting nature (both external and inner physical occurences) with all of one´s senses, perceiving it with all of one´s senses, and in so doing opening up the possibilities for sensual awareness and change.

A stabilisation of identity should be encouraged in girls by the inclusion of the aesthetic (here physical movement, dance, theatre, and video work) and of Gestalt educational approaches. The feelings of self esteem and self confidence can be strengthened by using Gestalt educational approaches, for example, like the imaginary journey and painting. This is achieved by becoming aware of negative feelings and being able to deal with them. Gestalt therapy assumes that "awareness of one´s body" is important for high self esteem. "Breathing and relaxation exercises, together with movement help one to become more aware of one´s body. The image that a person has of his body is an important part of his self image" (OAKLANDER, 1981, pg. 352). It is important to develop a positive feeling about oneself.

The course was carried out by the author in collaboration with Marion Engmann (movement/dance), Margret Hamann (video) and Gabi Stein (information technology education). Girls aged between 13 and 16 years from secondary modern and grammar schools took part in the 7 day course in 1988.

The course contained the following components:

Component 1: Information Technology Education

The introduction to progamming with Logo was carried out by means of turtle graphics. First of all the girls made imaginary drawings, only once they had done this did they write programmes. At the end they used the computer to write greeting-postcards. By doing this they got to know how to work with Logo objects and recursive programming. Video material was used as a basis for learning about the uses and effects of information technology. They were given an insight into the production of computer graphics and their importance for military purposes in connexion with turtle graphics. The question "Is computer graphics art?" was also discussed. The above drawings formed part of the theme of "girls and computers" in the theme complex of "girls/women and technology/ computers"; they formed the basis for a discussion group about subjective experiences. They examined the problem of the role of women in the media by means of a collage which they made from pictures and printed material from computer magazines, and about which they wrote commentaries. A short introduction about the role of women in the history of data processing was designed to make the specialist skills of women in this area clear. At the end of the course they had the opportunity to express their imaginings and feelings concerning the successful use of computers in an imaginary story. The aim was to admit to possible fears and in doing so to overcome them.

Component 2: Movement, Dance and Drama

Imagination and creativity, human communication and interaction, emotion and sensual awareness are the central themes of the physical work in the course. The aim of dancing and drama is encouraging and equipping people to improvise - to be able to perceive themselves, others and their environment in a new way at each moment, to be able to do the unexpected, react spontaneously, accept the process which results from this and to be able to move as they wish during the whole process (ENGMANN/HAMANN, 1989, pg. 24ff.). Sensibility and physical awareness are promoted by methods from the areas of "rhythmics" and "creative dance"; by expressive playing and "free drama" improvisation is possible within a short span of time which make the spontaneous expression of fleeting moods possible by means of free role play.

Component 3: Video - The Use of Technology for the Expression of one's own Perceptions

Video was included as a useful combination of technology and artistic work. "The girls used video cameras to find their own means of expression and to express themselves... During the course those taking part experimented with the camera and made small film sequences. Their technical knowledge was schooled by practising zooming in and panning, trick shots, constructing a plot, and by getting to know what materials are used in film making" (ENGMANN/HAMANN, 1989, pg. 25).

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TRENDS IN ENROLMENT OF GIRLS/WOMEN IN SCIENCE IN JORDANIAN SECONDARY SCHOOLS AND UNIVESITIES

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Gender differences in attitudes toward and enrolment in science has been a subject of importance and interest among educators and psychologists over the past two decades. A considerable amount of research has showed that in most countries in the world, there are gender differences in the selection of academic tracks (science vs. nonscience) in secondary schools. For example, in Jordan, only 37%of the tenth graders who selected the science track in 1987 were girls.

Chivers (1984) reported that, in West Germany, there is a general concern about the number of girls studying physics in any depth. To illustrate, he reported that only 33%of high level secondary students who enrolled in physics courses in 1980 were girls. In contrast, 81%of the secondary students who enrolled in biology courses were girls.

Likewise, Imsen (1987) reported that, only 13%of secondary students in Norway, selected the scientific track. In contrast, 47%of the boys entered the scientific track.

In Finland, although women and men have an equal role in the working life, they are working in different tracks. A recent Finnish study (Peltonen, 1987) reported that only 25% of the girls, about age 18, in the high school plan to choose a scientific (male) track. Moreover, only 3.4%of the girls in the age 15 plan to do the same.

In Poland, Chivers (1984) reported that in the year 1940, girls represented less than 5%of science students. However, in the year 1981, girls represented 28%of the students in secondary science track.

Gender differences in enrolment of high school students in science courses lead to differences in educational opportunities and rewards. In Jordan, although the proportion of men who enroled at the university of Jordan in 1983 was only slightly greater than the corresponding proportion of women, there was greater gender imbalance in science disciplines. For example, only 25% of the students in math were women, a ratio of one to four. Women were less likely than men to major in physics and chemistry as well (ratios of about 1 to 5). While women were as likely as men to major in biology.

Similar findings were reported in almost every country in the world. For example, the National Science Foundation (1984) reported that, in the United States in 1981, although 50% of undergraduate students were women, only 35% of science students were women.

Likewise, in Kinya, Marangu (1987) indicated that, men have dominated the science disciplines, ever since the introduction of university education. And, although the enrolment of women in science disciplines at Kenyatta University has been increasing steadily during the past decade, science is still dominated by men. For example, although first year women students have increased from 29 in 1977 to 100 in 1986, when one considers the total of first year enrolment in 1986, this is only 28%.

In England, Head (1979) reported that although 35% of students in higher education were women, they represented less than one in seven in physics and less than one in six in chemstry. Similarly, in Singapore, Gremli (1987) reported that the proportion of women enroled in the applied science faculties and tertiary institutions is only a fraction of the number of men in the same faculties and institutions.

However, this is not the case in the Fillippines, where women constitute 68% of chemistry students at the university level (Useem, 1984).

Indeed, these are depressing results, given that most countries in the world have legislation against sex discrimination in education, and compulsory school programs which aim at promoting sex equality.

This study aims at investigating the trends in enrolment of girls/women in science in Jordanian secondary schools and universities during the years 1967-1989.

SECONDARY EDUCATION

Very recently, the Ministry of Education, in Jordan, launched its 10:2 system. That is, 10 years primary education and 2 years of secondary education. The curriculum is sex nondiscriminating in that boys and girls take same courses from primary through secondary school. In primary schools, students of both sexes study same courses. At the end of the ninth grade, students, of both sexes, have to select either a science or a nonscience track.

Table (1) represents the enrolment rate for both sexes in first and second secondary classes in Jordan, during the years 1967-1987. The table indicates that the enrolment rate for first secondary school girls, who selected the science track has been on a steady increase, during the twenty years. To illustrate, the enrolment of girls in science has increased from 501 in 1967 to 5305 in 1987. This increase is impressive,

TABLE (1)

ENROLMENT OF STUDENTS BY GRADE, STREAM, AND SEX FROM THE YEARS (1967-1987)

		1st Grade			2nd Grade		
Scholastic Year	Sex	Sci.	Lit.	Tot.	Sci.	Lit.	Tot.
1967-1968	Boys	1985	2122	4017	2352	2941	5293
	Girls	501	1030	1531	481	1096	1577
1968-1969	Boys	2203	2933	5136	2603	2810	5413
	Girls	656	1458	2114	510	988	1498
1969-1970	Boys	2470	2504	4974	2376	3320	5696
	Girls	661	1283	1944	630	1371	2001
1970-1971	Boys	2515	2818	5333	2740	2691	5440
	Girls	765	1452	2217	645	1244	1889
1971-1972	Boys	2901	4048	6949	2550	2800	5350
	Girls	986	2356	3342	700	1453	2153
1972-1973	Boys	3303	3357	6660	3223	3965	7188
	Girls	1130	2004	3134	932	2260	3192
1973-1974	Boys	3790	2883	6673	3631	3513	7144
	Girls	1383	2061	3444	1170	2062	3232
1974-1975	Boys	4072	3216	7288	4193	3040	7233
	Girls	1757	2836	4593	1421	2101	3522
1975-1976	Boys	4641	3499	8140	3895	3885	7780
	Girls	1953	3452	5405	1871	277	4588
1976-1977	Boys	5321	3788	9109	5024	3691	8715
	Girls	2211	4058	6269	2007	3554	5561

TABLE (1) CONTINUED

Scholastic Year	Sex	1st Grade			2nd Grade		
		Sci.	Lit.	Tot.	Sci.	Lit.	Tot.
1977-1978	Boys	6475	6087	12562	6084	4448	10532
	Girls	2825	6171	8996	2320	4378	6698
1978-1979	Boys	6975	5786	12761	7440	6262	13702
	Girls	2584	6303	8887	2678	6199	8877
1979-1980	Boys	8244	6897	15141	7509	6312	13821
	Girls	3615	8135	11750	2784	5783	8567
1980-1981	Boys	7930	6710	14640	9085	7170	16255
	Girls	4084	8694	12778	3656	7470	11126
1981-1982	Boys	7805	6980	14785	8187	7063	15250
	Girls	4798	9892	14690	4399	7610	12009
1982-1983	Boys	8271	6411	14682	8840	7162	16002
	Girls	5026	9434	14460	4462	9092	13554
1983-1984	Boys	8587	7004	15591	8791	6570	15361
	Girls	5366	10334	15700	4927	9036	13963
1984-1985	Boys	7953	7417	15370	8720	6925	15645
	Girls	5022	9839	14861	4992	9246	14238
1985-1986	Boys	8413	7036	15449	3340	7060	15400
	Girls	5386	10306	15692	5124	8983	14107
1986-1987	Boys	7891	7505	15396	7988	7347	15335
	Girls	5305	11264	16569	4695	9800	14495

SOURCE: EDUCATION STATISTICS UNIT MINISTRY OF EDUCATION, AMMAN, JORDAN.

but when one considers the total of enrolment in the 1986/87 academic year, this is only 40.2% . Similarly, the second secondary school girls, who selected the science track, has increased remarkedly during the last twenty years. The enrolment rate increased from 481 in 1967 to 4695 in 1987. When one considers the total of enrolment in the 1986/87 year, this increase is only 37.02%.

Moreover, table 1 indicates that, over the last twenty years, girls were underpresented in the science track. For example, in the year 1968/69, girls constituted only 16.4% of the total science students, a ratio of 1:6. In the best case ever, in the year 1986/87, girls constituted only 40.2% of the total science students.

UNIVERSITY EDUCATION

Gender differences in enrolment in secondary school science track lead to differences in educational opportunities and rewards. According to the data from Yarmouk University Statistical Yearbook (1976-1989), one can observe that since the establishment of Yarmouk University, in the academic year 1976/77, till now, women were underrepresented in the science field, as table 2 indicates. In 1976/77, only 19.4% of science students were women. The table also indicates that the enrolment rate for women in science courses rose from 70 in the year 1976/77 to 993 in the year 1988/89. This increase is impressive, but when one considers the total number of students enrolled in the 1988/89 academic year , this is only 39.3%.

Table 2 also indicates that between the years 1976 and 1982, the enrolment of women in science had grown up. Growth has been noted in both women enrolment and ratio of women to men in enrolment in science. However, the number dropped to 882 in 1983/84, and to 873 in the year 1984/85. Then, there was a remarkable increase in women enrolment in 1985/86, followed by a remarkable decrease in the year 1986/87. During the years 1987 - 1989, the enrolment of women rose up from 856 to 993.

If one considers the total enrolment of students in science, he/she will notice that in the year 1976/77, only 19.4% of science students were women. This percentage has improved steadily during the years 1977-1980. Then, it has dropped out to 30.5% in 1981/82, followed by a steady increase in the following years, until it reaches the highest ever in the academic year 1988/89.

TABLE (2)

STUDENTS ENROLLED IN THE SCIENTIFIC DEPARTMENTS BY SEX DURING THE YEARS 1976-1989

Academic Year	Total	Men	Women	Women Distribution
1976/77	360	290	70	19.4%
1977/78	621	465	156	25.1%
1978/79	884	630	254	28.7%
1979/80	1168	777	391	33.5%
1980/81	1726	1125	601	34.8%
1981/82	2313	1607	706	30.5%
1982/83	2814	1908	906	32.2%
1983/84	2691	1809	882	32.8%
1984/85	2556	1683	873	34.2%
1985/86	2698	1734	964	35.7%
1986/87	2349	1493	856	36.4%
1987/88	2508	1564	944	37.6%
1988/89	2525	1532	993	39.3%

SOURCE: YARMOUK UNIVERSITY STATISTICAL YEARBOOK

Table 3 illustrates the students' enrolment in physics. chemistry, and biology during the years (1980-1989). The table indicates that over the last nine years, men have dominated the physics and chemistry disciplines, but not the biological sciences. The table also indicates that the enrolment rate for women in physics rose from 2 in the year 1980/81 to 105 in the year 1988/89 . This increase is highly impressive but if one considers the total number of students enrolled in the year 1988/89, this is only 27.9% . However, this is not exactly the case in chemistry . Although women were under-represented in the chemistry field, over the last nine years, the ratio of enrolment of women to men never went beyond 60%. In the year 1981/82, the ratio was 95.5%. In the other years, it was in the seventies per cent. Moreover, the case is totally different for biological sciences, wherein women have dominated this field over the last nine years. For example, in the year 1982/83, 93 women were enroled in biological sciences, whereas only 35 men did the same, a ratio of 3:1 . This result may be explained in terms of the notion that women are more likely than men to enrol and major in biological sciences,because it is the only scientific field which they perceive that their success and competence, with men, in it,is both lawful and legitimate since it compromises with society's expectations.

Finally, means and ways must be sought to find out the constraints and influences that keep out girls/women from scientific endeavors. Also, strategies for securing greater proportion of girls/women in science must be suggested.

TABLE (3)

STUDENTS ENROLLED IN PHYSICS, CHEMISTRY, AND BIOLOGY BY SEX DURING THE YEARS (1980-1989)

Academic Year	Sex	Physics	Chemistry	Biological Sciences
1980/81	Men	15	34	21
	Women	2	28	32
1981/82	Men	16	22	18
	Women	5	21	29
1982/83	Men	76	67	35
	Women	12	48	93
1983/84	Men	91	52	43
	Women	34	31	100
1984/85	Men	321	203	110
	Women	82	154	247
1985/86	Men	304	214	122
	Women	101	150	255
1986/87	Men	258	200	114
	Women	109	156	233
1987/88	Men	336	272	152
	Women	54	225	289
1988/89	Men	376	256	126
	Women	105	186	271

SOURCE: YARMOUK UNIVERSITY STATISTICAL YEARBOOK

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WOMEN'S CHOICE OF CAREERS AT THE UNIVERSITY

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ABSTRACT

Studies carried out in Costa Rica (Esquivel & Brenes, 1988) with data from national assesment tests in the basic subjects, no gender difference was found in mathematics until the third grade. In the upper grades a gender difference in the mathematics results was found.

A study was done to see if this gender difference had an effect in the women's career choice at the Universidad de Costa Rica.

Data from students that graduated between 1982 and 1985 was obtained. It was found that the more mathematics courses a career had, the less women that follow it. However no relationship was found among the number of mathematics courses and the choice that men do.

This shows that mathematics is a factor in women's choice of careers, but not in men's.

INTRODUCTION

Several studies trying to explain the mathematics gender difference have been made, depending on the author's point of view and political standing: biological or social explanations.

Studies carried out at the Universidad de Costa Rica, Dr. Juan Manuel Esquivel and M.Sc. Margarita Brenes (1988), with data from national assesment tests given to third, sixth, seventh, tenth and eleventh grade students, no mathematics gender difference was found at the third grade level. From the sixth grade on there was a difference, and the difference was greater in the upper years. These findings do not seem to be explained by a biological perspective. On the other hand, students of both sexes have in Costa Rica the same number and types of mathematics courses, since no choosing is permitted.

The objective of this paper is to study the effect that this difference has on the choice of careers at the Universidad de Costa Rica.

METHODOLOGY

Data of students, divided by sex, graduating in the different careers was obtained from the Estadisticas Universitarias published by the Instituto en Ciencias Economicas, from 1979 to 1985.

The data is from students graduating with a Bachelor's and Licenciatura (almost Master) degrees.

A study of the number of mathematics courses required by the different careers offered by the University was made through the Catalogo Universitario.

Percentages by sex, were obtained for the data of the years 1979, 1982, 1983, 1984, 1985.

Data from years 1980 and 1981 was given by semester, in percentages, making it impossible to get only one result for each year.

Careers were divided in five groups, according to the number of courses in mathematics that they had: none, one, two, three or four, five or more.

The University organization shown is the one currently used at the Universidad de Costa Rica. In the paper the bigger academic units were called Schools. Most of them were divided into what was called Departments.

Among the schools that have departments, data shown was not divided for the School of Arts, Letters, and Agronomy, since all the departments had the same amount of mathematics' course requirements. The rest of the schools that are shown do not have departments. The School of Letters has the Departments of Philosophy, Philology and Languages. The School of Arts is divided in Dramatics, Music and Plastic Arts. The Agronomy School is divided in Phytotechnology and Zootechnology.

Data that comes under Engeneering is obtained from the graduates of Civil, Mechanical, Electical, Industrial, and Chemical Engineering.

The existing data was not divided for the different careers offered in an academic unit. For example, students graduating in High School Mathematical Education are counted in the Mathematics Department with the Mathematics students.

A correlation analysis was ran to see if there was any significant relation between the number of Mathematics courses requires by career and sex of the graduating student.

RESULTS

The next tables shows the results obtained.

Universidad de Costa Rica
Distribution of Departments and Schools by
number of courses required in their curricula

None	One Course	Two Courses	Three or Four Courses	Five or More Courses
Philosophy Languges Philology Dramatics Music Plastic Art Law Education Communication Political Sci. Hist.& Geogr. Nursing	Anthropology Psychology Sociology Social Work Architecture Microbiology Dentistry Medicine	Biology Bussiness Adm Public Adm. Pharmacy Agricultural Ec Philotechnology Zootechnology	Geology Chemistry Economics Statistics	Physics Mathematics Mechanical Eng Chemical Eng Civil Eng Electrical Eng Industrial Eng Computor Sci.

Table #1

Graduates, by sex, by number of Mathematics courses

# Mathematics Courses	1982					1983				
		Men		Women			Men		Women	
	Total	#	%	#	%	Total	#	%	#	%
None	886	247	27.9	639	72.1	860	254	29.5	606	70.4
One	447	191	42.7	256	57.3	442	172	38.9	270	61.1
Two	632	440	69.6	192	30.4	507	330	65.1	177	34.9
Three or Four	70	47	67.1	23	32.9	100	64	64	36	36
Five or More	243	206	84.8	37	15.2	235	179	76.2	56	23.8

Table #2

Graduates, by sex, by number of Mathematics courses

# Mathematics Courses	1984					1985				
		Men		Women			Men		Women	
	Total	#	%	#	%	Total	#	%	#	%
None	659	239	36.3	420	63.7	680	232	34.1	448	65.9
One	370	127	34.3	243	65.6	338	135	39.9	203	60.1
Two	592	366	61.8	226	38.2	370	261	70.5	109	29.5
Three or Four	90	61	67.8	29	32.2	72	50	69.4	22	30.6
Five or More	269	233	86.6	40	13.4	271	222	81.9	49	18.1

Table #3

The following table presents the percentage of women graduating at the main campus, by academic unit ordered by number of Mathematics courses required.

Percentage of Women Graduating (Bachelor and Licenciatura)
by Career, Ordered According to Number of Mathematics
Courses Required
1979 - 1985

MAIN CAMPUS	1979	1980		1981		1982	1983	1984	1985
		Feb.	Aug.	Feb.	Aug.				
Total	53.8	60.5	56.2	56.6	47.9	50.2	51.8	49.9	49.7
None									
School of Letters	77.8	81.8	75.0	76.6	63.2	69.6	72.7	60.5	77.9
School of Arts	50.8	53.3	66.7	80.0	44.4	63.5	48.3	65.5	58.6
School of Law	26.8	44.2	30.6	58.1	26.1	43.0	39.2	38.3	46.4
School of Education	78.9	76.4	78.9	77.5	80.4	81.9	85.7	82.9	84.7
Dept. Political Sci.	13.3	0.0	8.3	66.7	0.0	36.0	38.7	41.2	55.0
Dept. Communication	58.5	68.4	11.1	80.0	60.0	64.7	71.1	66.0	71.7
Dept. Hist. & Geogr.	51.5	53.6	57.1	41.7	47.1	52.9	60.4	60.0	46.2
Dept. Nursing	95.9	94.1	91.9	100.0	100.0	96.2	89.7	100.0	85.3
One course									
School of Microbiology	49.3	---	54.5	---	62.5	67.4	63.2	81.1	58.8
School of Dentistry	47.3	52.3	42.9	46.4	63.6	53.7	64.4	59.6	53.4
Dept. Anthropology	*60.7	83.3	66.7	72.7	66.7	44.4	63.2	85.7	76.8
Dept. Psychology	83.9	89.5	90.0	88.9	91.4	83.8	79.7	85.5	95.5
Dept. Sociology	*60.7	58.3	66.7	55.6	63.6	46.7	56.7	46.2	58.3
Dept. Social Work	91.0	95.8	96.6	97.8	100.0	80.0	100.0	97.3	94.7
Dept. Architecture	---	0.0	70.0	20.0	10.5	26.7	21.2	16.0	15.4
Dept. Medicine	24.6	30.2	---	24.8	---	32.0	41.2	43.6	42.9
Two courses									
School of Agronomy	14.0	25.6	20.9	25.0	35.6	18.3	16.5	29.6	32.2
School of Pharmacy	78.1	80.0	---	86.8	90.0	85.0	65.5	84.0	100.0
Dept. Biology	39.0	66.7	66.7	48.1	52.9	55.2	51.9	64.0	58.3
Dept. Bussiness Adm.	32.9	50.0	39.3	50.0	39.4	35.0	42.0	36.7	36.8
Dept. Public Adm.	10.0	25.0	0.0	29.2	---	14.0	24.2	30.4	25.0
Three or four courses									
Dept. Geology	0.0	0.0	---	0.0	12.5	0.0	33.3	12.5	37.5
Dept. Chemistry	44.4	38.5	41.7	60.0	66.7	23.8	39.6	42.3	20.7
Dept. Economics	25.0	50.0	28.6	0.0	50.0	21.2	23.3	30.0	25.9
Dept. Statistics	30.0	66.7	66.7	---	---	78.6	71.4	46.2	75.0
Five or more courses									
Dept. Physics	28.6	0.0	50.0	0.0	50.0	33.3	30.0	0.0	22.2
Dept. Mathematics	27.3	26.7	23.5	42.9	40.0	66.7	58.8	33.3	40.0
Depts. Engineering	8.1	3.6	11.1	8.4	7.1	8.1	12.4	12.6	11.7
Dept. Computer Science	22.2	33.3	0.0	31.2	18.2	23.8	48.9	19.0	35.3

Table #4

The results from the correlation analysis are shown in the following table.

ABSOLUTES

	WOMEN		MEN	
YEAR	R	S	R	S
1982	-0.85	0.035	-0.23	0.357
1983	-0.85	0.035	-0.36	0.237
1984	-0.90	0.018	-0.06	0.464
1985	-0.83	0.042	-0.09	0.440

Table #5

DISCUSSION

Discussion of Table #4

- Careers with none or one mathematics course required

Law and Medicine both have a low number of mathematics courses but still have a greater number of men. These careers have traditionally been considered men's careers and are of the oldest, most prestigious, and with higher earnings ones.

Political Science and Architecture have a higher number of men even though these are new careers.

In both Dentistry and Microbiology, even though in 1979 more men graduated than women, the percentages changed with the years. More women than men graduated in 1985.

Apart from the six careers mentioned above, the other fourteen careers with none or one course in mathematics have more women than men graduating.

- Careers with two mathematics courses required

The students graduating from Biology could have finished either Biology or High School Education with emphasis in

Biology.

Pharmacy should be given special consideration. It is a women's career. As in Statistics, studies should be made of its prestige, income and work availability.

- Careers with three or more mathematics courses required

Statistics is the only of the twelve careers with these requirements that has a greater number of women than men graduating.

Computer Science is a new career, and it doesn't have the same pattern as the rest of the Engineering School. Studies should continue to see if it mantains the pattern or not.

General Discussion

The percentage of women graduating in these years is around or over 50%.

As can be easily seen from Table #5, there is a significant relation every year, for women, between the number of mathematics courses required and the career choice. No relationship was found for men.

There is a gender difference in the choice of career.

Because they have difficulties or feel unsure with matehmatics, women are being discriminated or are discriminating themselves from careers that require mathematics courses. Not being able to choose according to their inclinations could affect women not only in their personal feelings, making the studies more difficult and less rewarding, but in their economical situation too. Careers defined as women's careers are less well paid and with fewer job opportunities in Costa Rica: nursing, teaching, social work, languages.

In Costa Rica the only professionals that do not have to follow the "Professionals Minimum Wage Scale" decreed by the "Ministry of Labor" are the teachers and nurses, who have their own salary scale which is lower. This causes a great difference in the amount earned by women professionals since most teachers and nurses are women and most women study these professions.

The careers that have always been male careers, but are changing into female careers, like Pharmacy, could loose some of their prestige, lower the average salary, get saturated. It would be hard to find out what was first, it changing into a female career or men not following it because of less favorable conditions.

A study should be made to see if there is a gender wage difference. Probably women's income is a lot lower. One explanation could be that women prefer to work in more stabel jobs with better social guarantees, and in Costa Rica that would be found in a public job. This can easily be seen in a study done by the "Ministry of Planning" that shows that on March 1985 three fourths of the Costa Rican working force was receiving wages, but 86.2% of the women's work force was a wage earner, in comparison to the 70.7% of the men's work force. In Computer Science, the earnings of the people that work in the public jobs and receive a fixed wage are a lot lower than the people that work in the private section or freelance.

It could be thought that on public jobs the salary earned by women and men should be the same, since there are laws of eaqual salary for equal jobs in Costa Rica. This is not the case since the same study shows that women's salary is 10% lower than men's. In the private sector, women's salary is 71% of men's.

In the "professional and technical" group, women receive 69% of men's salary, partly because of the career choice and partly because women don't have high responsability jobs. This is easily shown in Education: of the 238 high school instituions, (public, private, semiprivate) 75% of the teachers are women. The distribution of principals in these institutions is 191 men and 47 women. There are 18 regional chiefs none is a woman.

The statistics by sex show that women are only the 9% of the administrators or executives in Costa Rica. Since this is the grcup that has the highest fixed wage, it is easy to see the financial problem that women have.

COSTA RICA: AVERAGE WAGE AND DISTRUBUTION OF WAGE EARNERS
BY SEX AND OCCUPATION (in colones)
March 1985

	MEN		WOMEN	
	Wage earners	Wages	Wage earners	Wages
TOTAL	342 524	8 205.9	136 845	6 906.10
Professionals & Technitians	28 975	17 616.80	24 847	12 088.00
Administrators & Executives	7 023	20 068.70	866	17 701.30
Employees & vendors	52 931	9 280.70	35 872	8 323.20
Blue collar & craftsman	214 108	1 677.30	23 721	5 331.50
Personal de servicio	38 918	7 847.70	51 173	3 957.70
Ignored occupation	569	6 225.50	366	4 983.70

Source: Dirección General de Estadistica y Censos y Ministerio de Trabajo y Seguridad Social, Encuesta Nacional de Hogares, Empleo y Desempleo

CONCLUSIONS

Even though women have been going to the University at a proportion similar to men, they have been following traditional defined "women" careers. These careers do not have or have very few mathematics courses. These careers are not the new technological careers.

Even though there is no data available on the earnings by career, it is easy to see that the amount earned in careers with majority of women is lower. It seems to be possible to prove that the amount earned in careers with several mathematical courses, Law an exception, is higher than the careers with fewer mathematical courses.

I don't believe that the only factor that influences women to follow a career is the number of mathematics courses, but the study shows that it is a factor that should be taken into account. This is not the case for men.

A study should be made in Costa Rica to find out more about the other factors that influence the career choice: peer preasure, traditional male careers, jobs compatible with child rearing, available role models.

All this information would enable us to understand better the pattern of choices women make, and would help in getting a real equity in career choice.

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THE POSITION OF WOMEN IN HIGHER TECHNICAL EDUCATION IN THE NETHERLANDS

A quantitative and qualitative description.
Research results, change strategies and activities.

Loes Marinussen

VHTO, the Netherlands
(VHTO is the Dutch abbreviation for the foundation 'Women and Higher Technical Education')

Summary
In the Netherlands few women choose to study at a Technical College. Since 1981 the VHTO seeks to increase the participation of women in Higher Technical Education (HTE). This article gives a quantitative and qualitative description of the position of women in HTE. This description is based on research. The results of research provide the groundwork for new policies and activities, of which a summary account will be given.

1 Introduction

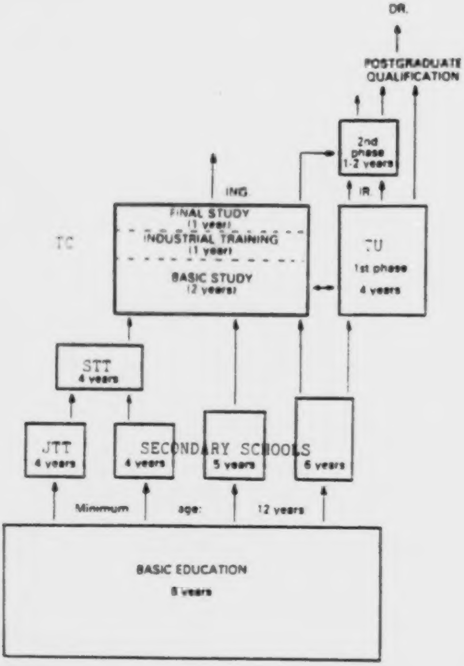
1.1 Higher Technical Education in the Netherlands.

In the Netherlands there are two types of education for engineers:

1 The Universities of Technology (TU). In this training students concentrate on research, systems analysis and the construction of abstract models
2 The Technical Colleges (TC). This training concentrates on the interpretation and implementation of abstract models and the adaptation of such models to industrial projects, in fact the development of concrete processes, manufacturing methods and structural design.

This article only concerns the latter type of education: the Technical Colleges.

This diagram shows the structure of the education systems in the Netherlands in relation to technological education.


DR.
POSTGRADUATE QUALIFICATION
2nd phase 1-2 years
ING.
IR.
TC
FINAL STUDY (1 year)
INDUSTRIAL TRAINING (1 year)
BASIC STUDY (2 years)
TU
1st phase
4 years
STT
4 years
JTT
4 years
SECONDARY SCHOOLS
4 years
5 years
6 years
Minimum age: 12 years
BASIC EDUCATION
8 years

There are 29 Technical Colleges providing education in daytime. The courses at these colleges take nominally four years. Together the Technical Colleges offer twenty-one different courses, although not every College offers all of them.
The total number of students is between 25,000 and 30,000. Only 6% of this group of students are girls.

1.2 VHTO

The VHTO, Women and Higher Technical Education, is founded in 1981. The aim of the foundation is to increase the participation of girls in Technical Colleges and subsequently in the labour market.
In order to achieve this objective in Higher Technical Education, a general emancipation policy was developed.
Its principal elements are:

- the information and enrolment policy is to be directed at girls;
- to create a social climate in which more girls feel at home than the present select group;

- teaching has to be geared to girls;
- to promote a positive policy for enrolling female students, taking on female teachers and staff, and getting women in management teams of schools;
- to set up network activities for female engineers on the labour market.

Through information and training the VHTO seeks to improve the position of girls at Technical Colleges. The VHTO also conducts small-scale qualitative research in order to locate the specific problems for girls. The results of research provide the groundwork for emancipation policy and activities.
The VHTO is state subsidized.

2 A quantitative description

The number of women participating in HTE is low in the Netherlands. Since 1977/78 the percentage of women slowly increased from 1.8 to 5.7 (see table 1). Since 1987/'88 the disadvantage of women in this field doesn't seem to catch up. The female students are not evenly distributed among the different courses (table 2).

table 1: number and percentage female HTE-students

year	number	percentage
1977/'78	362	1,8%
1978/'79	455	2,2%
1979/'80	598	2,7%
1980/'81	676	2,9%
1981/'82	857	3,3%
1982/'83	1046	4,2%
1983/'84	1245	4,5%
1984/'85	1353	4,8%
1985/'86	1498	5,2%
1986/'87	1682	5,7%
1987/'88	1773	5,7%
1988/'89	1843	5,7%

The success rate at HTE turns out to be equal for male and female students. For the five academic years 1979/80 - 1984/85 the percentage of students who finished a course is both for male and female students 70%, that is 70.4% and 69.6% respectively.

3 Qualitative description - research results

3.1 Girls in secondary education, taking interest in technology, about Higher Technical Education.

Girls which have mathematics and physics as final examination subjects can choose for HTE. Only few girls actually make this choice. It happens frequently that a girl enrols at a HTE institution, but later on

Table 2: distribution of female students in 1984/'85

	number	percentage
automative engineering	2	0,4%
management science	132	10,2%
architectural engineering	198	6,9%
chemical engineering	169	9,8%
clothing manufacture	145	58,2%
computer engineering	5	1,3%
industrial economics	22	4,7%
electrical engineering	61	0,8%
engineering physics	17	3,6%
computer science	247	10,9%
surveying	12	7,8%
metallurgy	2	3.0%
town and country planning	45	19,2%
naval archintecture	0	0,0%
transport engineering	14	11,8%
traffic engineering	41	12,3%
aeronautical engineering	6	1,7%
civil engineering	60	2,3%
mechanical engineering	56	1,0%

decides not to go through with it. The VHTO wanted to know whether HTE-guidance is sufficiently accessible to girls and whether it meets their requirements. To this end interviews were conducted with seven girls who had enrolled at a HTE institution, but withdrew later on.

Results:

- Technical Education in general has little appeal for the girls who were interviewed. They are only interested in the course of their choice, other HTE courses are not in their line. About these courses they have the same mistaken ideas as any other girl.
- The main motives for the choice of a particular course are a special interest in the chosen field of study and the good opportunities on the labour market. However, HTE-guidance does not include information on career opportunities for female engineers.
- It seems that for a first introduction to HTE girls turn to written material; they only visit orientation days when they are certain about their choice for HTE. The girls who were interviewed think this written information is unsatisfactory.
- Girls who do visit an orientation day are not encouraged to choose for HTE. These orientation days give a wrong impression of the course. Practical aspects are overemphasized and the students to be are overwhelmed by a mere show of technique (the most recent and complicated machines are demonstrated and the accompanying explanations are full of technical terms. And boys even seem to understand all this). Girls are overawed by all this and get the impression that their technical knowledge is insufficient.
- Girls are very uncertain as to their choice for HTE. HTE-guidance does not offer the necessary information to remove doubts or prejudi-

ces.

- It is not clear what level of preparatory training one should have for a course in HTE. The success rate in HTE is low, as a result of which it is often alleged that HTE studies are very difficult. This puts off girls more easily than boys.
- Reasons not to go through with HTE:
  . uncertainty about the level of difficulty and the necessary preparatory training, about how much practical knowledge and skills are expected, and about the proportion of theory to practice in the educational programme;
  . the low percentage of girls;
  . it is thought that little attention is being paid to the creative aspects of technique, to the implementation of technique in society and to more general skills like managing people.

3.2 Opinions of female students

Students and drop-outs of Technical Colleges were interviewed in order to find out how they experience HTE. The following information is based on ten interviews with female TC students and eight interviews with female drop-outs.

Reasons not to finish a course.
The drop-outs who were interviewed withdrew from their studies in the first or second year. The reasons they gave mainly concern the level of study, although their study results were often reasonable. Other reasons they mentioned concern the school's atmosphere and study guidance. Adaptation to the new environment is essential to study success.
Like male students, girls do not withdraw from HTE because of a lack of interest or motivation.

Effect of the school's atmosphere
As from the start of the course the adaptation to their new environment is different for HTE students and drop-outs. For example, both groups of students feel different about the introduction period. During this time HTE students had fun and made friends, although they criticize the introduction programme. The criticism of the drop-outs, however, concerns the atmosphere during the introduction. The large number of students and the childish behaviour of some of the boys turned the introduction into a rather annoying experience. The girls immediately felt that they were part of a minority group.
Initially both female students and drop-outs experience the same problems. Those who continue, however, turn out to be more successful in making contacts. To give an example: during the interview the students were asked about positive and negative aspects of HTE. As a positive aspect the female students mentioned mixing with their fellow classmates. Almost all female students think that male classmates appreciate their presence. They have gathered some friends around them, mainly classmates. The majority of them have close friends at school. Friendship is made both with male and female students. The majority of the drop-outs, however, mentioned mixing with classmates as a negative aspect: they said their classmates ignored them, made sexist jokes and prejudiced remarks. In conclusion we can say that female students succeed in becoming part of the group, whereas for drop-outs adaptation is a troublesome process.

The role of the teachers

All female students think that the relation between teachers and students leaves much to be desired. The female students believe that the teacher's concern with their students is inadequate. "They are not interested in students", "they don't appreciate students", "students are not taken seriously".

The female HTE students and those who dropped out feel that teachers treat male and female students in a different way. One teacher ignores girls, whereas another gives them extra attention. The female students feel that they are not accepted by all teachers. They are confronted with all kinds of prejudices.
Teachers could fight an important battle for female students if they corrected sexist behaviour of male students. But when it comes to this, their own behaviour is questionable. They ignore such incidents or even take part in them, but hardly ever do they correct the boys' behaviour. Girls would probably dislike it anyway if it was done openly: still, girls should be able to count on this form of protection.

Counseling

Most institutes of HTE have created facilities for student counseling. They often have a dean of student affairs, a departmental mentor or a class tutor. There is an enormous variety of facilities at HTE institutes. The entire counseling system proves to be inaccessible because it is not sufficiently publicized, because students hesitate to make use of it, or because students do not trust the people involved in this system. Many female students are not familiar with the facilities at their institute. Fifty percent of the drop-outs did not contact anyone at their institute before they dropped out. The drop-outs who did seek advice were not satisfied by it. In HTE it is a tradition that people are treated in an impersonal way, that teaching is concentrated on the subject matter alone and that there is little interest in 'soft' activities like talking, guidance, consultation and creating an atmosphere. Student counseling is often not taken seriously by management or teachers. Students cannot help but notice this; consequently they have no expectations whatsoever of counseling and they will not make use of it.

The school-building

The female students think that institutes of technology are rather cheerless places. The areas for coffee, tea and lunch breaks are also without atmosphere. And what is more, the buildings are still lacking facilities for girls, such as cloakrooms and clean toilets.

Contents of study

The female students believe that the training they receive prepares them for their future profession. Two things are lacking, however. Firstly, information on prospective job levels, and secondly, care for the personal development of students in order to prepare them for a supervisory position.
At present the students' contribution to the educational programme is limited. The female students take this for granted, the drop-outs disapprove. The drop-outs would also like to see that the programme offered more room for the social aspects of technology.

Teaching methods

There are considerable differences between teachers. The prevailing opinion of female students about the didactic qualities of teachers tends to be negative. They criticize the way knowledge is imparted, the teaching methods, and the teacher's professional expertise. For the female students, the teachers are the scapegoats in HTE. This in contrast with the drop-outs, who focus their criticism on male students.

3.3 Management and counsellors about Women and HTE

The objective of this study was to take stock of (the opinions of) the policy on the participation of women in HTE and to make a general survey of the problems involved. In order to gather information, methodical interviews were conducted with one member of the management team and one student counsellor of all thirty-four HTE institutions in the Netherlands. During the interview fixed items were brought up inducing the member of the management team or the counsellor to find a connection with the position of women. A form of active research. This study took place in 1986.

Results:
- The visit of VHTO research workers to HTE institutions increased the willingness to participate in activities organized or initiated by the VHTO.
- The interviewees believe an increase in the number of women participating in HTE would have positive effects. The most important advantages are thought to be that the atmosphere within the technical sector of higher education will be improved, and that a rise in the number of female students will maintain or increase the total number of students. However, there is no policy to recruit more women in HTE. This goes for women in management teams in particular, but also for female teachers. In order to bring in more female students, some HTE institutions have organized information activities specifically directed at girls.
- Special information activities for potential female students are accepted methods to enrol more girls in the institution. An employment policy giving priority to women is not accepted.
- It is generally believed that the present female students feel at home in HTE, and it was repeatedly remarked that women who would find it difficult to adapt, do not choose for a HTE course.
- The opinions about the consequences of being in a minority position differ noticeably. More than one third of the interviewees think female students have more problems than male students, and almost half of the interviewees assumes that their special position affects the way they function (in whatever possible way).
- One third of the counsellors judge it necessary that female studentes receive extra counseling. The rest of the counsellors disagree, for the following reasons: female students do not indicate they need extra counseling; extra counseling would be discrimination; there are not enough girls.
- The most frequent forms of extra counseling are:
  . a tutor for female students
  . a contact group for female students.

  The initiative is taken by the student counsellor, who is often supported by the management teams. This is ususally not the case when teachers or students take the initiative. At this moment twelve HTE institutions have an emancipation co-ordinator. These co-ordinators have taken over (nearly) all extra counseling activities at their institution.
- Not one HTE institution made use of the class grouping policy to put all female students together in one class, although this is a rather

simple way to decrease the problems for female students of being in a minority position.

- A few institutions recognize the specific difficulties women have during practical training, but little is done to clear up those difficulties.
- Eighty-three percent of the counsellors who were interviewed think that women need special preparation for the labour market. This happens nowhere.

3.4 Teachers in Technical Colleges about female students

Since a few years major changes are taking place in Dutch Technical Colleges. Many TC's amalgamate, thus becoming gigantic institutions. This has far-reaching consequences both for students and teachers. Training is no longer given to small groups but to large student audiences. The number of lessons drastically diminishes. More students have to be trained in less time and with less manpower. This presents additional problems, especially for girls.

In 1988 twenty-three teachers were interviewed. They were teachers of Electrical Engineering and Chemical Engineering. These fields of study were chosen because in Electrical Engineering only 1% of the total student population is female, while in Chemical Engineering 10% is female.

Every HTE teacher must have at least three years of working experience in industry. Half of the teachers who were interviewed do not have didactical training. Some teachers think it is difficult to get qualified staff because of bad working conditions, low salaries and a high pressure of work.

- More than half of the teachers thought that at the beginning of their studies girls were at least as good as or maybe even better than boys. However, there was a difference of opinion between Electrical Engineering and Chemical Engineering teachers. All teachers thinking that girls are worse than boys are Electrical Engineering teachers, and most of the teachers thinking that girls are better than boys are Chemical Engineering teachers.
- Almost half of the teachers observed that it must be difficult for girls to function among all these boys (at school) and men (during practical training). The girls might feel lonely, be teased, be taken less seriously, have to listen to sexist remarks, and so on. Especially Chemical Engineering teachers, who are more used to girls in their classes than Electrical Engineering teachers, made these observations.
- More than half of the teachers think that girls are more likely to receive special attention and help from fellow students and teachers during work and practical training. The teachers have never asked themselves how the girls would feel about this special attention and helpfulness.
- The results of this study prove that teachers are aware of the fact that girls are in a special position in HTE. However, they do not draw any conclusion with regard to their own behaviour. They think they treat boys and girls equally, and that this is the right way to treat them. Nevertheless, girls experience their teachers' behaviour in class in a different way. But any example they give is not accepted by the teachers. The teachers cannot comprehend that girls experience their behaviour as such.

4 Policy on emancipation

Below you will find a summary account of HTE emancipation policy in the Netherlands. Many of the activities resulting from this policy were started some years ago and are still being carried out on a smaller or larger scale. Information on our experiences with these activities and their results will be provided at the conference.

4.1 Study information for secondary school students

- materials to attract the attention of girls: posters, stickers, brochures
- changing the attitude of student counsellors
- research into the girls' need for information
- information for girls: video, brochures
- special information days for girls
- changing recent information

4.1 Coaching female students

- decreasing the problems caused by the minority position; organizing networks; placing girls together in the same group
- a journal for female students
- national meetings to share experiences
- a tutor for female students

4.3 Changing the attitudes

- conferences
- visiting the institutes
- a journal with information about HTE barriers for girls
- improving the training of teachers

4.4 Improving staff management

- temporary positive discrimination
- part-time work
- day-care facilities
- parental leave

4.5 Improving the contents of study

- application training
- training in life-planning
- a labour-market brochure

4.6 Supporting female engineers

- research into the problems
- training in life-planning
- networks

WOMEN IN SCIENCE AND TECHNOLOGY IN DENMARK.

Mette Vedelsby, Roskilde University Center, Denmark

Abstract:

The distribution of students by gender in science and technology is unequal in Denmark as in many other countries. The unequality has decreased over the recent years, but is now apparently stagnant or even increasing again.

In this article I will only look at the engineering educations at the technical universities. There has been made other investigations about women and engineering in Denmark (Billing and Bruvik 1984,ref1) (Kolmos 1989 ref2). Each of these investigations concentrate on a specific technical university. In this project, however, I am going to compare the educations at the two technical universities in Denmark (AUC and DTH).

INTRODUCTION:

The Danish Council for Research Policy and Planning has ordered me to map out women's recruiting to the higher educations in science and technology during the last ten years in Denmark. I am going to compare the same subject (e.g. physics) at the different universities with respect to the amount of male/female students and the drop-out rates, and to find out whether the style of teaching and the educational climate influence on these factors. I am also going to compare different subjects (e.g. physics and biology) at the same university as regards the above mentioned factors. I am paid 2/3 salary for a year.

I started the project in August 1989. Therefore, I have not finished the collection of data. In my research I am using quantitative and qualitative methods. I am collecting statistical data from the universities, giving questionnaires, following female students on common studying days, and interviewing them afterwards. In this article I will only look at the engineering educations at the technical universities.

THE DROP OUT RATES:

> *"When I tell people that I am an engineer student, I am told that I don't look like an engineer. It is probably because they have the attitude that girls don't receive this education. They don't have a picture of a female engineer."*

The percentage of women admitted at the two technical universities in Denmark has grown through the last 10 years from about 10 to above 20% .(fig.1)

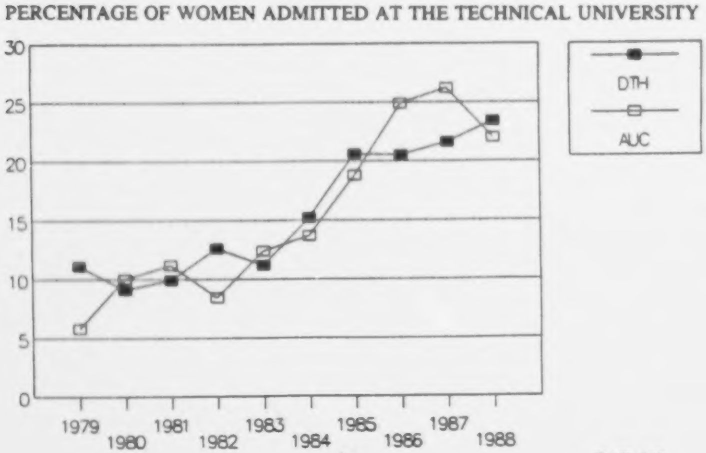
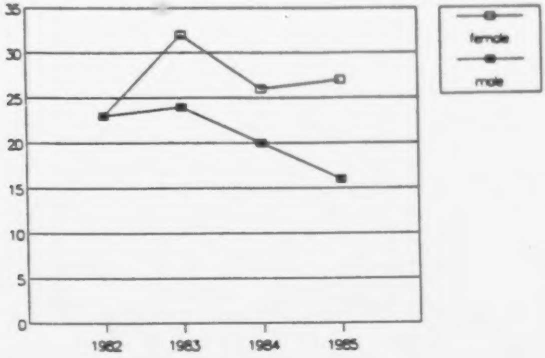


FIG. 1

Even though the percentage of women at the engineering educations has grown, the drop-out rate among women is still higher than among men. (fig.2 and fig.3)

TOTAL % DROP-OUT RATE FROM INITIAL YEAR UP TO OCT. 1989, AUC.



INITIAL YEAR

Fig. 2

There are more than one possible explanation of that :

1) Because of a greater need for engineers in society, in the recent years, there has been made a lot of efforts to get more women interested in technical studies. If somehow women have been "tempted" into the studies, this could be the reason for a higher drop-out rate.

2) When women are students at the technical universities, they tend to choose other branches than men (ref.1,ref.2). That means that in some of the branches , such as e.g. the mechanical branch, there are still very few women. The drop-out rate for the women is relatively higher in these branches (ref.1).

3) In a project about "Girls and Physics" in the upper secondary school (age 16 to 19)(ref3) we have seen (as also described by many other authors) that girls and boys develop different learning-styles. Girls are defensive in their reactions and characterised by a fear of making a fool of themselves. In contrast, the boys are more offensive, they are compelled by an urge to achieve. That means that girls have a tendency to evaluate their own performances lower than boys do. Finally, there is a difference in the way that boys and girls meet a challenge, and that plays a major role when they are in the process of learning new concepts. Girls generally feel that they must have a thorough understanding of a subject before they can proceed to a new one, whereas boys do not mind going on to new problems before they have thoroughly understood the old ones; and that way of learning gives better results in the long run. Even among the girls who have chosen a study in science subjects, some will keep the above mentioned learning style. And many of them, as well as their surroundings (teachers, friends, family), think that they are not as good as the boys in the subjects.

As a female physics student told me:

> *"I think that you will easier drop out if there are few girls at the study. Because some of the boys will show the attitute of -just knowing everything- and you can easily be knocked down by that, or lose courage, and think that you are the only one who don't understand. .. We thought that the boys were really clever. But when we saw the marks, after the written tests, we found out that the boys didn't get better marks; we were even better than some of the boys".*

Another female physics student told me:

> *"Once in a physics class we had a really difficult problem to solve at home. I had been working on it for a long long time, and I found the correct solution. But when I got it back from the lecturer, he said, " You surely have a boy-friend in a higher level physics class".*

Sometimes the girls must convince the teachers that they are good enough in the subjects , before they believe in them.

As indicated above, there are still a lot of reasons why the drop-out rate for women is higher than for men at the engineering education.

THE STRUCTURE OF THE ENGINEERING STUDY AT THE TWO TECHNICAL UNIVERSITIES - DTH AND AUC - IN DENMARK.

Ellen van Oost and Saskia Everts , The Netherlands, have argued that an interdisciplinary project-organized approach in engineering education will attract more women to engineering (ref.4). This agrees with what we found (ref.3) for upper secundary school girls in physics: thematic teaching results in a higher motivation, and that the subject of the theme and its perspective is very important especially for the girls .

The structure of the engineering education and the way the studies are built up at AUC and DTH are completely different.

At **AUC** the technical-natural science educations all begin with the same two foundation terms (one term lasts six months). The purpose of these terms are e.g. to learn the students some general things about how to work in groups, how to delimit a problem and to understand the interdisciplinarity of all subjects. Furthermore the students are going to get a general overview of the technical and natural-science subjects and they are going to have some basic courses in mathematics, physics and computer science.

After the foundation year, the students can choose to continue the study to become a surveyor, a master in mathematics and physics, or computer-science, or choose one of 5 different branches of engineering science. Both in the foundation year and in the later studies the education is project-organized. You spend around half of the time on projects and the other half on lectures and on problem-solving classes. At the beginning of each term the students form groups (5-8 persons in each group) selected on the basis of personal relations and professional interests. Each group will have its own group room for the whole term. The education is problemoriented, which means that the problem for a certain term is going to be solved through education, searching for information, group-discussions, and making working-papers. At the end of the term the group has to to make a project report, in which the progress and the found solutions are described.

If you have chosen one of the branches of engineering science, you can -after two years at the branche- decide whether you want to finish six months later as a bachelor in engineering or you want to finish 1 1/2 years later as a master in engineering. It is only at the final project you get a mark. At all the other evaluations (oral or written) , you can only get passed or not passed. (The Minister of Education wants this to be changed, but so far I don't know in what way, though he wants more marks).

At DTH the structure is quite different. The students have to take several compulsary courses in mathematics and physics. And in addition to that they can choose among a great deal of different courses. Most of the education is lectures, and associated with some of the lectures there will be guided problem-solving classes. Most of the courses take one term of six months and are finished with a written test, for which you normally get a mark. To diminish the drop-out rate, a study-start program lasting one year was introduced in 1988. In this program the students have to choose among 6 branches. In the first six months the teaching will be partly in classes (about 25 persons), partly at lectures (about 150 persons), and partly in groups (about 8 persons). After this program the students can choose almost as they wish.

To become a master in engineering will at least take 5 years both at AUC and at DTH.

Because of the probably more girlfriendly structure at AUC you could expect that a higher percentage of the students at AUC would be girls, but that is not so. Fig.1 shows that in this respect there is no difference between AUC and DTH. But what about the drop-out rate then?

Total % drop-out rate from initial year up to 1989.

Initial year	AUC		DTH	
	female	male	female	male
1982	23	23	44	32
1983	32	24	39	36
1984	26	20	44	36
1985	27	16	39	35

Fig.2.42

If we compare the drop-out rate from the two universities, we see a destinctively higher rate at DTH both for the male and the female students. Could that be because of the structure and the educational style at AUC?

In 1987 1124 (881 m. and 243 f.) were admitted at DTH and 581 (451 m. and 130 f.) were admitted at AUC. The two universities are placed at a distance of about 300 km from each other. One could probably expect that there would have been more applicants for AUC when the drop-out rate is lower there, but this is not the case. If you investigate where the applicants for the universities originate from, you will observe that most of them are from the surroundings. That could mean that the structure and the teaching style are not the most essential factors. Often it is difficult for young people both to begin a study and to leave their friends. It is also very expensive for them to move to an other part of the country. The other thing is that they may not have been as well informed by the counsellors about the universities which are placed in another part of the country.

It is too early for me to make conclusions, but I hope that the project will end up with some proposals to increase the amount of women starting and finishing the studies of science and technology.

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WOMEN AND SCIENTISTS

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Introduction

A year ago we completed an investigation of science textbooks for lower secondary schools asking if they were aimed more at boys than at girls and giving the answer "yes". We had studied one physics and one chemistry book and some booklets in integrated science looking at different aspects of the books, one being how scientists, contemporary and historically, were portrayed.

Not surprisingly, it was obvious according to the books that the scientist was, and is, a man. The only historic woman scientist was of course Marie Curie, but she was named only in the physics book. The chemistry book in which there was a table over important elements and their discoverers did not list radium or polonium and thereby missing out Marie Curie. The booklets in integrated science told about many historic scientists, both wellknown and more unknown, but did not mention any woman.

We consider these books representative for science textbooks concerning women and science. The message to the girls is that there has not been any women scientists, except perhaps Marie Curie. As the conditions for women in society and in education are subjects not much studied in schools the girls might draw the conclusion that science is more suitable for men or that women are not clever enough for science. The teachers might bring the subject up but it is not likely as they probably have no knowledge of women scientists either. Maybe they would if they had come across the subject during their education?

We have made a pilot study on women scientists and are planning for a book aimed at students in teacher training colleges and have now completed a first draft. In this paper we present parts of our discussion about recruitment and retention of women in science.

The scientists

We chose to present the work and life of six top women scientists. Four of these women are nobel laureates, the other two for different reasons never got the prize although they worked together with prize-winners. We here present them briefly before we go on to the discussion.

Marie Sklodowska Curie (1867-1934) was born in Poland. To be able to go to university she had to leave Poland, where girls could not enter the University of Warsaw. After being governess a couple of years she managed to go to Paris in order to study mathematics, chemistry and physics. In Paris she met Pierre Curie. They married and Marie stayed in France to do research together with her husband. She studied radioactivity and found the new element radium. She got the Nobel Prize in both physics and chemistry, 1903 and 1911. She died of pernicious anemia, caused by the radiation she had been exposed to.

Lise Meitner (1878-1968) was born in Vienna. Her parents were of Jewish origin. She was very interested in physics, but had to pass an examination in French to be able to support herself as a teacher, before she got the permission to study physics. She went to Berlin 1907 where she for many years collaborated with the chemist Otto Hahn. In 1938 they bombarded uranium with neutrons and studied the products. In the summer 1938 Lise had to leave the Nazi Germany. She was smuggled to Holland and then she came to Sweden. Here she got the results from the experiments in Berlin which made her conclude that they had produced nuclear fission.

Irène Joliot Curie (1897-1956) began working at her mothers institute after studies at Sorbonne. She took her PhD in 1925. She married Frédéric Joliot and together they continued the research on radiation. They had two children. 1935 they were awarded the Nobel Prize for the discovery of artificial radioactivity. Later they worked on different projects connected with radioactivity. Although Iréne from early on suffered from her exposure to radiation she continued to do research and to teach until the end of her life.

Maria Goeppert-Mayer (1906-1972) studied quantum mechanics in Göttingen and took her PhD in 1930. The same year she married the american chemist Joe Mayer and went with him to USA. This was the time of the depression and no university would think of employing the wife of a professor. But Maria kept working with physics. 1946 Mayers went to Chigago and Maria became a voluntary associate professor. Because of the nepotism rules the university couldn'nt hire both husband and wife so Maria got no salary for her work. 1963 Maria got the Nobel Prize for her developments of the nuclear shell model.

Dorothy Crowfoot Hodgkin (born 1910) who became interested in chemistry as a child was educated at Sommerville College, Oxford (1928-1931). She studied X-ray crystallography in Cambridge (1932-4) working with J. D. Bernal, and was appointed a research fellow of Sommerville in 1933, becoming a tutor and fellow in 1936. She married in 1937 and had three children. She became a University lecturer 1946, a Reader 1955 and Research Professor 1960. She was awarded the Nobel Prize 1964 with the motivation that she had solved structural problems with X-ray diffraction techniques, the most important being penicillin and vitamin B 12 . Later she determined the strucure of insulin. She has received numerous awards and travelled a lot in connection with science.

Rosalind Franklin (1920-1958) came to Newnham College, Oxford 1938 after studies at St Paul's Girls' School determined to become a scientist. She became a research fellow 1941, but left Cambridge for London and CURA, an institute for research on coal 1942. There she worked with microstructures on different carbons and completed her Ph.D. After the war she spent some years in Paris, learned X-ray diffraction technique from Jaques Méring and studied carbons, almost amorphous, with that technique. She returned to London 1950 and began working with biologically important molecules still using X-ray diffraction, first at King's College where she was involved in research on DNA and then at Birkbeck, studying viruses.

Brightness is not enough

All six women grew up in families where both parents were interested in the education of the girls. The atmospheres in the homes were stimulating with interests also in art, literature and music, mainly from the mothers. The mothers were in most cases working even outside the homes, at least before their marriages.

Even so, the road towards the university was not laid out for five of our girls. Only Rosalind Franklin, the youngest, went straight through school to university. Different arrangements were made for the others, with governesses, private schools, a cooperative and in several cases special studies for the entrance to the university.

The studies of the girls were expensive for the parents. Marie Sklodowska had the most difficult situation, which was solved through the great loyality in the family. Lise Meitner's family paid not only private lessons prior to her university entrance but also the university studies and research after her graduation.

Neither the Goeppert and nor the Curie family was especially well off but in those families university studies were considered normal also for girls. Franklins had a lot of money and for this reason Rosalind's father did not find it necessecary for her to go to university, but he consented.

And the universities? Were they open for women? In Vienna round 1900 and in the twenties in Goettingen there were no formal problems, nor in Paris. In Poland, however, the road was closed for Marie Sklodowska.

Oxford and Cambridge admitted women but there were restrictions during the times Dorothy Crowfoot and Rosalind Franklin were students. The number of women was limited and women did not have the same the examination rights as men.

The young women we are discussing were very bright and had a strong wish to study and to study science. It could not have been possible without support from the parents. There were no straight roads to the university for girls, no matter how clever and gifted, as there were for boys. Support from the parents was a decisive factor for a girl's possibilities to get into science. The parents'interest and maybe also economic sacrifices were necessary.

The academic career

It was not easy for a woman to make a living doing research in the first half of the twentieth century. Marie Curie, Lise Meitner and Maria Goeppert-Mayer all worked many years without pay.

Marie Curie could do research, but without payment, together with Pierre. One year after the couple got the Nobel prize she was offered her first paid research job. Later she was the first woman in France to became a professor. The reason was, however, the death of her husband as she was made his successor.

Lise Meitner got her first paid employment six years after her dissertation. Later she worked in Berlin at an institute, funded by the industry. Maria Goeppert-Mayer followed her husband to USA where he held posts first at John Hopkins university and then at Colombia. Neither of these universities were interested in employing Maria. She got part time jobs in military projects, though. It seems as if the universities, at least in Germany and in USA, were more negative to women than private institutes or stately, military projects.

Dorothy Hodgkins had at first difficulties finding a job or research money and later she was for several years a College Fellow with no University responsibilities, while most of the men had parallel appointments. Irène Curie had, thanks to her mother, no difficulties in starting the research career but came later in the shadow of her husband. Rosalind, born 1920 does not seem to have had difficulties either with getting jobs or scholarships.

In order to get appointments, schoolarships or research grants support from colleagues or superiors is needed. The support is important even informally. Ideas are born in discussion with other people why it is necessary for a researcher to discuss and argue with scientists in the same field. As science is a male bastion support from the men is needed.

Marie and Irène Curie both had their husbands as the most important collaborators. Pierre introduced Marie to other physicist and Irène met them already as a child. Irène worked together with Frédéric until 1937 when he left the Radium Institute for a new nuclear research laboratory of which he was made director. But they were still able to support each other.

Maria Goeppert-Mayer's husband was un important partner but she had support also from many well known physicists. At home in Goettingen the Goeppert family had friends as Max Born and James Franck. Born became Maria's supervisor and later cooperated with her in USA, where she also met Franck again. Enrico Fermi was a friend with whom Maria discussed and he is said to be the one who put her forward for the Nobel prize.

Lise Meitner was supported by several colleagues. She worked for many years with Otto Hahn. She belonged to a group around Max Planck and frequented his lectures and seminars. There she discussed with scientists like Nernst, Einstein, Franck, Hertz and Geiger. It was a group of people who helped and encouraged each other. She became much more isolated when she came to Stockholm as a refugee.

When Dorothy Crowfoot grew up and when she was a student there were always family friends who could help with advice or useful contacts. Through such a contact she 1932 came to John

D. Bernal in Cambridge as a research student. He was an authority on X-ray crystallography and at that time very exploratory. Dorothy Hodgkin has said that all her subsequent work started with looking at crystals with Bernal. For a time, when Dorothy was back in Oxford she often returned to Bernal as she felt scientifically isolated in Oxford, although she built up contacts even there.

Bernal later moved to Birkbeck in London. He came to play a part also in the life of Rosalind Franklin. She came to Birkbeck 1953 after a period at King's College and collaborated successfully with among others Aaron Klug. Unfortunately she died after only a few years, which Bernal in an obituary wrote was a great loss to science.

The women we are discussing all had friendly support and encouragagement from other first class researchers. We are sure this is an important reason for there success. Formal rights was crucial but so was the informal support.

The art of being woman and scientist

There was also resistance. The male scientific establishment was slow in accepting female researchers. Royal Society elected the first women members 1945 while Académie des Sciences waited until 1979. The resistance in France was especially evident as they refused both Marie and Irène Curie membership. Even less important organizations left women out. As a young don in the thirties Dorothy Crowfoot was not allowed to be a member in Oxford's Senior Alembic Club for chemists. When Rosalind Franklin worked at King's College in

London in the fifties women were not allowed to use the dining room for the researchers. This effectivly shut her out from the important informal discussions.

There were other ways of blocking the women. Round 1915 a publisher wanted an article on radioactivity from L. Meitner, but refused to accept it when he realised that L stood for Lise. This was only one example of the resistance against Lise Meitner.
The discrimination of Maria Goeppert-Mayer in the US was apparent. As late as 1959 she got her first paid university post. Before that no university was willing to pay her although she was a PhD in quantum mechanics. The formal reason was the rule against nepotism. It was not possible to pay both man and wife. An effective way of keaping women out!

Rosalind Franklin was during her time at King's College discriminated in a more hidden way which became unintentionally known through the book "*The double helix*", by James Watson. The male researchers could obviously not handle the talented young woman who refused to subordinate herself. She was frozen out although she made important contributions in solving the structure of DNA.

Even if these women managed to became parts in the scientific community they still had other problems than the men. Kathleen Lonsdale, one of the first women in Royal Society, wrote: "*.For a woman, and especially a married woman with children, to become a first class scientist, she must first of all choose* *or have chosen, the right husband. He must recognize her problem and share them."* Marie Curie, Irène Joliot-Curie and Maria Goeppert worked with their husbands and had support and encouragement from them. Dorothy Hodgkin and her husband managed to create marriage and life in such a way that careers were possible for both, although it sometimes was very complicated. These women had all chosen the right man.

But - husband and wife did not have the same conditions. The women had responsibilities for home and children and in some cases even for the husband's personal service. They managed with assistance of grandparents, nurses and maids but even so the men had more time for research or relaxation. The women worried more. Maria Mayer told about her conscience for neglecting the children, while Joe Mayer said he nearly lost contact with them!

Another solution was to stay unmarried. Lise Meitner never married. Nor did Rosalind Franklin, which was a conscious decision, a conclusion drawn from the discussion among women in Cambridge concerning career or marriage. Rosalind thought that she by not marrying should be regarded as a scientist and not as a woman scientist. She was wrong in that respect.

Today in Sweden?

We have a compulsory school, formal rights and equity laws but gender structure is still reproduced. Science is maledominated and the unpaid work is mostly done by the women. The resistance is more hidden and difficult to point out. Looking at our "foremothers" is one way of analysing our own situation.

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LEARNING BY DOING - AN OLD METHOD STILL GOING STRONG

Pre-school teacher attitudes towards teaching technology and how they could be changed.

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Summary

Pre-school and primary school teachers are likely to influence the attitudes of the children they teach in many respects. The views and attitudes of those teachers towards science and technology and their abilities to teach these subjects have a decisive impact especially on the girls they encounter. Most of the Swedish pre-school teachers now working in the day-care centres have a non-science background. How does this affect their attitudes towards science and technology, and how do they react when exposed to in-service training activities in these fields?

Teknikens Hus in Luleå has investigated these matters in the course of a two-year project of developing and carrying out an inservice training programme for pre-school teachers in one district in the county of Luleå. The results of the evaluation of this project reveal a great need for further training and indicate the strong impact of training activities. The number of teachers involved is small, but the views and ideas they express as well as their suggestions and demands for the future are no doubt representative of most Swedish pre-school teachers to-day.

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1 THE TRAINING PROGRAMME

1.1 Goals

The training programme was planned in close co-operation with local child-care authorities. We agreed on the following goals for the project:

- to overcome the negative attitudes towards technology and to create an interest in teaching technology among pre-school teachers

- to find new methods to teach technology on a basic level

- to include experience from the project in the in-service training programmes of Teknikens Hus and to transfer this experience to the education planners at the Luleå Teacher's Training College

- to prepare new educational material suitable for pre-school technology activities

1.2 The participants

The staff of five day-care centres in one district of the city of Luleå were chosen to participate in the project. The number of teachers at these centres were 58 in total.

The district was carefully selected to reflect a broad variety of housing, economic and social standard of the inhabitants, the children involved thus forming a heterogenous group as far as social background is concerned.

1.3 The programme

Our programme was introduced to the teachers at a meeting in May 1986 at the University of Technology. In this meeting we decided to implement the programme in the following way:

Teachers from Teknikens Hus visit the day-care centres involved in the training programme to discuss and decide the contents of the training programme with the teachers.

All the teachers involved in the programme attend three different workshops at Teknikens Hus. Immediately after a workshop is finished, every pre-school teacher is responsible, with her colleagues, for the planning of how to present the contents of the workshop to the pre-school children.

Two primary school teachers of the staff at Teknikens Hus are prepared to go to the day-care centres to help the pre-school teachers get started in their work with technology. The staffperson from Teknikens Hus are not supposed to take over teaching, but to support planning activities and act as extra help when technology is taught at the day-care centres.

Planning for the next workshop is started after the ideas from the workshop have been tried out in the daily work at the centre.

After the first workshop and the pre-school work with technology among the children we all these outlines of a model for the training programme. There were no reasons found for any major changes in the in-service arrangements in the course of the programme.

During the two-year project, Teknikens Hus organized nine workshops altogether. The following areas were covered:

Water, snow, ice	e g temperatures, the melting of snow, the forming of ice; surface tension; plumbing, water seals etc
Paper making	how to make paper "by hand"
Electricity	home electricity, e g lamps, fuses etc
Simple machines	e g pulleys, levers
Tools	tools at home: tools for carpentry, for the garage etc.

Bicycles function and repair

"Classical" experiments were carried out in all these areas. The participants also worked on how to deal with everyday technical problems in the home.

We made a special point of encouraging the teachers to be more confident about their own abilities and not to be shy about their acting as role models to the children.

2 RESULTS AND EFFECTS OF THE TRAINING PROGRAMME

2.1 Evaluation method

Two years after the last part of the training programme was finished, in the autumn of 1989, we returned to the pre-school teachers who had taken part in the programme and made a series of interviews. The main objective was to see whether there were any long-term effects of the training to be found in the teachers' attitudes towards science and technology generally, in their teaching methods and the contents of their teaching. We also wanted to find out if the teachers had any suggestions on how to change the prevailing situation.

We were not able to get in touch with all those teachers who had taken part in the training, because of changes in staff and organization and also due to the fact that some of the teachers had left their jobs. The number of teachers involved in our survey is thus relatively small and consequently we cannot draw any general conclusions from our material. However, we found some common features worth pointing at.

Altogether we interviewed 15 pre-school teachers and day-care centre activity leaders. Some of the interviews were longer and more extensive than the others.

2.2 Results of the training programme

Before and after

From the interviews and from reports and schedules of the pre-school activities in the district where the training programme was implemented, we concluded that only a few of the teachers involved in the training programme had ever tried to work with technology before the programme started. Those who had thought about or tried to take up technology had done so e g while teaching about "old times", taking more of a historical view on technology. They considered "old" technology easier to understand and simpler to explain to the children. This was mainly due to their own uncertainty and lack of knowledge about science and technology generally and especially about the technology that surrounds us to-day. This feeling of uncertainty was stated as a very important reason why the teachers had never tried to work with technology.

Most of the teachers had taken up technology immediately after the training course, however. The only exception was a teacher who stated that she "was not inclined to" technology. The way in which technology was presented during the training programme - as a part of our own daily life - attracted the interest of the teachers and made them feel that technology was already a part of their own world and not something strange and frightening.

All those who had actually taken up technology copied the experiments they had learnt at the training course in the first place. They chose to work with experiments they had learnt to master and could cope with so as to avoid the feeling of uncertainty that still was predominant with many of the teachers after the training programme was finished.

The way of introducing the technology programme to the pre-school children differed. Most teachers presented it as "technology" or "technical workshop". One teacher wanted the children to feel excited and curious about the new programme, so she called it "Experiments".

When asked if they had gone on to different and more advanced experiments later on, many of the teachers answered in the negative. The reasons differed, and we will come back to these later. However, some had actually done so or were planning to do so, while others had tried to make connections to technology when teaching in other areas, as they were now aware of the fact that "technology is present everywhere".

It was obvious in all the interviews that the practical technical experience gained from the training programme was essential to the readiness of the teachers to start working with technology among the pre-school children.

Problems and difficulties

One big problem when it comes to implementation of training programmes in the everyday life at the day-care centre is the frequent changes of staff. Many of the activities in technology will call for co-operation between the staff members. Those who joined the staff in after the training programme and did not have the same experience as their collegues sometimes had difficulties in catching up. This often meant that the programme could no longer be effected. Obviously, the trained teachers were still not so self-confident as to be able to teach or train those who had not had any training. This suggests that the knowledge and skills must be considerable with each person before she can start teaching or even inspiring her colleagues. It is very likely that many of the efforts made to train teachers to train other teachers will be in vain, as long as the level of knowledge and skill is not higher.

In those day-care centers where the children spend only part of the day, the lack of time for planning and for doing the practical work often prevented the teachers from starting up the technology programme. These part-time centres frequently operate with one teacher only, and she is kept constantly busy, even though the groups of children in the part-time day-care centres often are smaller. Also a teacher is not likely to start up a technology activity on her own, without the encouragement and co-operation of a colleague.

The lack of confidence and the insufficient theoretical and practical knowledge was mentioned by almost all the teachers as a reason for not starting activities in technology before the training programme. It was also an obvious reason for not going on to different and more complicated activities. As long as the teachers could stick to the experiments they had been taught in the training programme, most of them felt secure. But the security and the practical skills they had acquired were restricted to the contents of the training programme. Going further meant a challenge that seems to have been good for some but too much for most teachers. Their lack of knowledge and security affected their motivation to go on and made them drop technology or at least not do any more experiments - even though they liked what they had done.

Attitudes may change

The majority of Swedish pre-school teachers are female, like in most other countries. Most of these teachers have chosen their professional education on the basis of a non-science/technology education in secondary school/high school, and very often even as a means to avoid dealing with subjects like science, mathematics and technology. Their teacher education has not contained any, or very little technology. Science and technology have been considered difficult, boring and complicated by most of these teachers - obviously due in part to lack of good science/technology teaching in earlier stages of their education. This has of course influenced their work with the children and made them very reluctant to approach any technical devices.

When the training programme was introduced to the teachers of the district we had chosen for this experimental first stage, we were also very careful to point out what we wanted to achieve, so as not to create the impression that we tried to entice the teachers into doing something they later would find out did not suit them. Under the given circumstances, it must be considered an enormous step for a pre-school teacher to take part in a training programme set up to promote the teaching of technology and a change of attitude towards technology as such.

One of the teachers we interviewed told us that she even had to ask the children for help to be able to manage the tape recorder she sometimes used at the day-care centre. It is of course impossible for anyone with that kind of a frustration towards technology to give the children a fair view of the role of science/technology in society to-day. Her attitude is also very likely to influence the views of the children on the roles of men and women in science and technology.

The feeling of uncertainty and inferiority has often also created in the teachers an attitude of resistance and even reluctance to the masculine world of technology. It has always been safer and more comfortable for the teacher to stick to the sphere of care, kitchen and other female occupations. This further strengthens the attitude of pre-school children towards men's and women's roles, given also the fact that this is a world dominated and controlled by women.

No doubt there was reluctance at the start of the training programme, at least on the part of some of the participants. One teacher even said she was deterred and frightened. But by stressing the practical points of the programme and letting the participants try experimenting on their own we managed to overcome their hesitation. We found them to be open-minded and ready to accept this new challenge. This is also what they experienced, according to the statements they made in the interviews. Some previously unhappy teachers claimed that the mere word technology had lost its fright and now has a positive value. Technology has become integrated into their own world, and so also into the world of the children they work with.

This dramatic change of attitude was in no way uncommon in the group of teachers. We found several reasons for this.

Not unimportant was first of all the fact that the educators at Teknikens Hus are mostly female, and they have a background similar to that of the teachers they were training. They acted as role-models, adding strength and courage to the participating teachers.

Another important factor was the de-dramatizing of technology that was achieved by pointing at the existent technology in the everyday world - the kitchen, the bathroom etc. This helped the participants see not only the close-at-hand technology but also the importance of knowing more about the things we all use daily. From there, it was easy to widen the scope to see the interrelationship between technology and society at large, e g in issues like energy, transportation, environmental problems etc. The teachers now have a more holistic view of society and technology, and they try to apply that attitude to the work they do in pre-school, by integrating technology into other fields or themes treated in the education.

Finally, maybe the most important change in attitude was achieved by the practical work done by the teachers did in experiments of different kinds. They found that they were able to master technology in a way they had never thought to be possible. They felt that their knowledge and practical skills were increased dramatically in a very short time, which also convinced them that they could learn more and that they could learn to teach technology to children.

Many of the teachers still expressed a feeling of insecurity towards technology, however. They stated very strongly that they know their own knowledge to be too limited, covering only the examples used in the training programme. Despite this feeling of uncertainty, their attitude towards technology was still a very positive one. The teachers said they were eager to learn more by attending further training or keeping in touch with the educators at Teknikens Hus. The help offered by our educators during the first part of the "home-work" period was mentioned as a good way of getting further into more difficult and demanding exercises.

Gender and technology

The whole training programme was really a case of trying to change the attitudes on gender and technology with teachers, children and parents. It is interesting to note that the only male teacher taking part in the training programme had some complaints as to the very different backgrounds of the participants and suggested a division of the group according to previous knowledge. No other participant suggested this. It is also worth noticing that one of the teachers, on practising the programme in her work-place, received some acid comments from the regular caretaking (male) staff. What she did was not considered proper work with the children!

The teachers themselves could not help seeing that the small boys seemed more at ease with technology than did the girls. Sometimes they were also more interested, but less patient at work with the experiments. Some girls would work very intensely and be very active, whereas the boys wanted to play games. Several teachers tried to work with separate groups of girls and boys to give the girls an extra chance. No teacher seemed to doubt that the girls would be able to do just as well as the boys, given the same opportunities.

Parents were also very supportive and had not expressed any prejudices about what boys should do and what girls should do. Some parents contributed to the programme by donating old technical devices like type-writers, radio and TV sets, alarm clocks etc for the children to investigate and take to pieces. But this kind of work almost exclusively attracted the boys, whereas girls were more interested in constructing landscapes, houses etc and including technology in a whole setting.

3 CONCLUSIONS AND SUGGESTIONS

3.1 Technology in pre-school?

Technology has so far not been a natural part of the pre-school activities in Sweden. Considering the world we live in, one must question the reasons for this. Technology plays an important part in the lives of each and everyone to-day, and it will continue to do so. It must be the responsibility of pre-school to make the children feel secure in their everyday world - and how could they if the technical devices that surround them and the way they function remain unfamiliar and even strange? How will the attitudes towards the roles of men and women in society ever change if pre-school children are allowed to grow up in a female non-technological and even technology-hostile world - a world where even the most familiar technical devices are considered too hard ho handle by their - female - teachers?

Teacher training now includes preparing the teachers for guiding the children into a very complicated world. Teachers are trained to treat subjects like war and peace, democracy, local and global environmental issues, cultural differences, minority problems - all factors influencing our world - but a world from which technology is almost totally excluded. Yet, technology is present everywhere, and has changed and will change our world more than anything else.

Our conclusion is that technology must be taught in pre-school, and that the teachers must be well prepared to do it!

3.2 Teacher training

The pre-school teacher training programme and its results points out the very great importance of education and teacher training, i e what is taught and how. As mentioned above, the pre-school teachers in the programme had had no previous training in technology at any level of their education and only basic science education in secondary school/high school and at the teachers' training college.

Lack of theoretical knowledge and practical skills accounts for a lot of the insecurity and reluctance felt by the teachers. Having considered their situation, most teachers find it frustrating to teach in an area where they have too little knowledge to be able to adjust their teaching to the level of the children and to answer all the questions arising from the teaching. One teacher said she did not even know how and where to find the literature she needed!

This general ignorance is the main reason why most of the teachers decided to stick to the experiments they had learnt and the knowledge they had acquired in the training programme and could go no further. Thus, if pre-school teaching is to contain science and technology, it is necessary to change the contents of the teacher training. Basic technology should be allowed to take a fair share of the scheduled time. The technology must be based on experience from everyday life and connected to already existing practical and theoretical knowledge of the surrounding world, where technology is playing an increasingly important part. So far, the basic science training offered at training colleges has been too much based on principles of science, physics etc. This does not help to overcome the fright and reluctance felt by the teachers towards modern technology. To give the teachers a feeling of security, comfort and enthusiasm when dealing with the technology of to-day, it is necessary instead to teach the theoretical background of "real" modern technology, to link it closely to the experiences of the students and to give them practical know-how.

3.3 In-service training

The pre-school teachers gave us a lot of proof to the idea that much more in-service training in science and technology will be required for the existing pre-school staff. Considering the level of theoretical knowledge among most pre-school teachers, it is only understandable that the need for both theoretical and practical training is very great, and it will take a long time and much effort to overcome.

Since the training project we have had the opportunity of training more than 1 000 pre-school teachers at Teknikens Hus. These training programmes have been based on our experience in the first pilot project accounted for here. We have accordingly proved in our activities that training courses containing a lot of practical work make the teachers feel confident about their own abilities and encourage them to go on experimenting on their own. But also the theoretical side of technology must be treated in the in-service training activities, to assure that the teachers acquire the necessary background. However, such theoretical training must be very carefully adjusted to the level of knowledge existing among the teaching staff, and this will require much pedagocical and scientific insight.

3.4 Final remarks

It is our hope that future pre-school teachers - be they male or female - will not have to put up with the frustrations which were so obvious in the teachers we met during the training programme. No doubt a change of the training programme for pre-school teachers must have implications for all teacher training. By changing teaching we can change the world - but we have to start now!

PROMOTING TECHNOLOGY AS AN INCOME-GENERATING ACTIVITY FOR GIRL DROPOUTS FROM RURAL AREAS - A CASE STUDY

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The study presented here is a successful miniscule techno-human experiment on the female resource of a little unknown Indian Village. The underscoring postulates of the model are :

a) technology is the most powerful transformative instrument available for humanity today, and can well be exploited as a developmental strategy in a country like India

b) human resource is the major capital in India with larger concentration in villages and any viable strategy for development should, therefore, start with *people*, particularly the most disadvantaged and less favoured segment, viz. *women in villages*

c) a systematic human resource development strategy involves a decentralised democratic pattern of technology with equitable gender justice, cutting across social divisions and reaching women at the grassroots

d) technical skills when related to career-goals and economic advancement motivates girls from rural areas to make a non-traditional occupational choice which will bring them out of their subserviant status to the centre-stage of progress

BACKDROP

Technology has assumed a paramount importance today as a transformative force and is treated synonymous with power in global relationships. In a developed country, technology has increasingly taken a systemic form of directing and dictating the nature of its future.

But an appropriate developmental strategy in Indian context should be indigenous and techno-human, reckoning with its multi-dimensional grassroot human problems and the rapid technological sweep all over the world.

India's human resource ranks as the highest among its available resources. By the end of this century, one billion will be its human numbers, women constituting almost half of the population. The country as such cannot afford to undervalue the potential talents of women or marginalise them in socio-economic progress.

But studies show that women form the major underutilised resource, more pronouncedly, in technical education and transfer of skills. Today, in India, the number of engineering colleges and technical institutions at degree level has risen to 150 and polytechnics to 450 with an annual admission capacity of 30,000 and 70,000 students respectively. The post-graduate courses in Engineering and Technology are offered at more than 80 institutions with an annual intake of more than 6,000 students. Sadly, the enrolement of girls in engineering and technology is found to be only 6 per 100 boys though the number of girls going in primarily for soft courses in arts and humanities had increased. It is because India still remains a gender-segregated society. Technology is considered as a male preserve. Girls also do not evince interest in technical subjects. Thus they are left behind to stagnate at the entry-points in the rat-race of progress. / India lives in villages but it is girls from villages who suffer more of deprivation and discrimination with poorer access to development as reported by the National Commission on Self-employed women.

Villages have primary and middle school facilities but secondary education continues to be more and more confined to urban areas. *[National Perspective Plan for women 1988-2000 A.D.]* The rural girls who manage to have secondary education suffer from their anomalous position. Due to economic and social constraints, they are neither able to pursue higher education and learn income-producing skills nor could they take up the cheap labour available in the countryside to eke out their living. Hence, even these few rural girls in the age group of 15-18, who manage to enter the secondary classes, dropout of school education and are left without any income-learning skill.

Any corrective technological strategy in Indian system, therefore, should be holistic. It should promote technology as an educative method as well as effectively confront multiple problems like lack of skills, unemployment and lack of access to better technologies, tools and productive assets, in a package manner.

REACHING OUT

The Alagappa University, Karaikudi in the Southern State of Tamilnadu, is headed by a woman Vice-Chancellor who is conscious of the most pervasive problems afflicting less-favoured women. She entrusted the task of evolving a suitable action-strategy as a remedial measure, to the Centre for Women's Studies of the University. The Centre singled out the case of girl dropouts after a survey of the nearby rural areas and tried out a strategy, harnessing female resource and exploiting technology for their socio-economic development.

The Centre adopted a Village Panchayat, 'Iluppakudi' comprising six little hamlets with women constituting 55 per cent of the total population of about 2,000. Undisturbed by the low hum of modernisation emanating from the nearby town Karaikudi (8 kms. away), men and women go about their work mostly as agricultural landless labourers and construction workers. 15 percent of the households with a moderate living have its male members either migrated to urban centres or involved in small business or own a few acres of land. To the rest of the 85 percent, it is a hard state of living as unorganised seasonal labourers, languishing under poverty line.

There is a school in the village at which the children can be educated upto the higher elementary stage. For further schooling, they should go to Karaikudi. Those who can afford town-bus fare or a cycle, send their children to secondary schools. In the case of girls, discrimination is enforced as they can look after siblings and be useful in the household work. Not all girls are sent to the village school and even of those who enter the primary level of education, many drop out at various stages.

Of the girls who managed to pursue secondary education in the town, none has entered the collegiate level. The girl dropouts are compelled to stay at home with no skill and no avenues opened for self-employment. In other words, they are thus subjected to a social and economic oppression virtually with least chance to improve their living conditions.

These were the major findings of an intensive door-to-door survey conducted by the Post-graduate students of Women's Studies. With these findings, the Department deliberated over the appropriate technological skill which will make the target-group selfreliant and selfsustaining. The governing objectives behind all these exercises were to falsify the myth that girls do not have a scientific temper and technological aptitude and to strengthen the view that even in remote areas where the benefits and applications of science and technology have not reached, girls with exposure and practice can prove themselves as human assets.

Therefore, the Centre decided on two non-traditional training courses for girl dropouts according to their level of education, viz. (i) Screen-Printing and (ii) Maintenance and upkeep of Domestic Electrical Appliances. Of the two, it is the Electrical Course that is dealt with in this paper.

Women and Electricity have never been considered compatible in the Indian social context. Electrical skills are dubbed 'masculine' involving risk and physical labour, and girls as electricians is something unheard of. One of the strange facts is that some girl trainees do not have electricity in their own households and still use oil lamps and kerosene lanterns. Almost all the trainees are not accustomed to the various domestic electrical appliances used by low and middle income groups.

The second promotive factor is the marketability of the skills. Of late, middle income households have started acquiring and using electrical domestic appliances like grinder, mixy, iron-box, water heater, toaster etc. Consumerism in these appliances is considered as a status symbol. In the case of career women whose numbers are on the increase, these appliances help lessening the drudgery. But these women users do not have a control over or knowledge about the appliances they use.

Considering the viability of this short-term skill training project, the Government took up the scheme as a Training for Rural Youth in Self Employment (TRYSEM) under the National Integrated Rural Development Programme and willingly came forward to fund the programme which included a monthly stipend to the trainees and the infrastructure was provided by the University.

Strangely, when applicants were interviewed for admission to these Courses, almost all the girls opted for Screen Printing as they considered it safer. Neither the trainees nor the parents could think of Electricals as a course for girls and were scared out of their lives in getting trained in electricity. But there was the enticement of stipends, which meant much to them. After gentle pursuation, the present trainees were selected for the Electrical Course.

When it came for appointing a trainer, we could not get a woman but fortunately came across an enthusiastic young man who was willing to play a key-role and cooperate in the novel venture. The curriculum was designed with the help of University Engineers who were careful not to relax or soften any theoretical/practical inputs required for the job.

The Course was conducted in the University campus where Post-graduates and Researchers move around with a scholarly air and work in sophisticated laboratories. The rural girls placed amidst them were shy and baffled at the beginning but quickly got adjusted and began to own the campus. Classes started with formal lessons on simple methods of safety and informal discussions on how strong women could be and equal to men in all respects.

The Vice-Chancellor made it a point to visit the workshed and appreciate various stages of trainees' progress in their skill-learning. This tempted the University Professors and scholars to visit the work-spot and offer suggestions. Once the word spread about this strange course, prominent citizens, officials including the Education Secretary of the State

Government, representatives of Women's Associations, and educationists came to see girls at work. These endowed the girls with self-importance and seriousness about their task. The girls themselves explained to the visitors the working of electrical appliances and methods of repairing.

The defective appliances from the households of the University Community were sent to the trainees for repair and orders were even received from the town-people. The trainees visited the households for repair work, and climbed up and down with great ease during their work, which quite surprised the housewives. Thus a social recognition was won for these girls from all quarters.

A uniform (of pants and shirts) was prescribed to facilitate the mobility of the trainees. Here again, was a resisting shyness to adopt a mode of dress to which they were unaccustomed. But gradually they adopted themselves to the idea of a work-uniform, felt at ease in it, and moved about without any inhibition in the campus.

Their training was systematically structurised with oral, written and practical examinations and record keeping. They began to draw exhibits on boards and hung them up on the walls, proudly signing their names on their products. The girls did so well that the Centre was tempted to offer additional courses in wiring and simple electronics. The parents have now reconciled themselves but still see their wards off every morning with instructions to be careful and wary. At last, society has dropped off sceptical remarks and wondered what would be the next stage in our strategy.

The Course provided them with hands-on experience which enhanced the girls' interests in the underlining scientific process and theories. The sense of excitement in working on the threshold of knowledge was visible. The trainees noted down that the science they learnt in classrooms in their formal education was insipid and dry without first hand practical experiences. Every time they made correct circuits and repaired the defective appliances, there was an exuberance.

Once when they made a fused tubelight burn without the usual accessories but with a specially devised condensor, they were at the height of joy and ran to the Director's room inviting her to witness their 'invention'. They made toys out of cheap local materials like wooden laddles with twinkling lights and felt excited when visitors receive them.

To make the skill marketable, the trainees were instructed in market survey and set out for a week's exercise and returned assured of a prospective market for their servicing. As electrical servicing along with the sale of electrical goods will be profitable, most of them have decided to start their own enterprise.

This exercise has brought to light another hidden potential in the trainees-the entrepreneurial spirit. This again is an area hitherto considered as 'male prerogative'. The process of breaking one barrier has eventually led to the breaking of successive barriers. The Centre organised parents-officials meet to decide upon the future course of things. The officials were cooperative in scrutinising the applications, clearing their doubts, and fixing the locale and agreeing to fund these girls' self-employment ventures. Now, the trainees are preparing themselves transforming technical skills into profitable income-generation.

A significant fact about the case presented here is that with a limited budget of Rs.50,000 (roughly US $ 2,500), the contours of a village could be transformed through women and the gates of a prospective future opened for its people. This was possible because of the responsive coming togetherness of three important components at the cutting-edge of the development process namely, the University, Government and Community.

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STATUS OF WOMEN IN SCIENCE & TECHNOLOGY IN INDIA : CURRENT TRENDS

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INTRODUCTION

One of the outstanding achievements of modern India has been the unprecedented awakening of Indian womanhood which in the past hundred years has been forging itself into full recovery. Various movements, both relegious and social, had sprung up in the middle of the 19th century, reforming Hinduism and the Indian society. India has been blessed with a number of great men and women who had pulled out the country from the groove in which it had settled. Their new ideas had swayed the sub continent and had brought about a silent revolution which began with the amelioration of women. This reached its climex in the political upheaval under Mahatma Gandhi when women broke with the past and came out of their seclusion and agitated for political freedom. With their emancipation came the advancement of education and new privileges to serve their homes and country. The revival has been one of fulfilment to women and to the nation.

Before going in the details of status of women in the restricted field of Science and Technology education, let us have a look at some general aspects of women Education in India.

WOMEN LITERACY AND SCHOOL EDUCATION

In general, the role of educational system in the life of an Indian girl is to reinforce the values of consistency and obedience in addition, the family creates an awareness and preperation for future life in her husband's home. For boys the stress is on competition and career. Theoretically, it is difficult to envisage how the same school system can have different sets of aims and consequences. But this becomes clearer when we look at the content of textbooks, the narrower choice of courses for girls and the low rate of women's participation in higher education.

The disparities in male female literacy rates are quite evident as shown in the graph. Further while there ware 1,055 illiterate women to 1,000 illiterate men in 1911, the former figures went up to 1,322 women to 1000 illiterate men in 1981. This gender gap is due mainly to the growth in absolute numbers.

While girls' overall school enrolment increased from 6.4 million in 1951 to nearly 40 million in 1981, this still accounted for only 12 per cent of the relevant age groups at all levels as against a figure of 20 per cent for boys. It is now more or less accepted that an obstacle impeding universalization of elementary education is the non-participation of girls. Further, the likelihood of the rural girl being out of school is much higher than that of the urban girl. At the secondary level, while only 13 per cent of

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girls in the relevant age group are in school, a meagre 17 per cent of these are from the villages.

Further there are substantial regional imbalances and differences : in Kerala, a southern state known for its general level of awareness, female literacy is as high as 73 per cent, whereas in Rajasthan, one of the nine states officially recognized as being educationally backward, less than 12 per cent of women are literate. Again, though the overall female literacy figures, according to the 1981 census is 24.8 per cent, in rural areas it is around 18 per cent, while in the towns and cities women's literacy has gone up to 47.8 per cent.

On the whole girls constitute only a third of total enrolments at every level of schooling and their dropout rate is higher than that of boys. Thus, although the number of girls enrolled in Indian schools has increased, many girls still leave schools at the elementary level (Tadesse 1982, Razafy 1969). There are a number of reasons which keep girls away from school. Important among these are (i) the high opportunity cost of education in relation to the poverty of families, (ii) social factors such as early marriage and a wide spread belief in female seclusion, increasing the demand for girls schools and women teachers and (iii) discriminatory processes at work within the school system itself.

WOMEN IN HIGHER EDUCATION

It is a matter of gratification that educational opportunities for women in the sphere of general and professional education at the university level have expanded appreciably in recent years. It is equally satisfying to note that women have responded with alacrity and availed of various opportunities which has accounted for increasing enrolment of women in all faculties and at all levels of education. In response to needs of the society and the demands of the public and private sectors, there has been reorientation in the education of women at the university and college levels. The highly specialized and professional courses in Science and Technology offered by universities have no longer remained a prerogative of men as more women, year after year are found competing for entry to these courses.

There has been a spectacular growth in the number of women enrolled in institutions of higher education. The enrolment of women as percentage of total enrolment increased progressively from 24.5 per cent in 1975-76 to 27.2 per cent in 1980-81, 29.6 per cent in 1985-86 and 30.6 per cent in 1986-87. Number of women colleges also increased proportionately and at present we are having more than 800 women colleges in the country.

WOMEN IN SCIENCE AND TECHNOLOGY EDUCATION

Faculty-wise distribution of women enrolment given in table shows that women enrolment in each faculty as a percentage of total enrolment in that faculty regestered a gradual increase from 1982 to 1987. Although the highest percentage of women enrolment in any faculty is recorded by the faculty of education with 50.5 per cent of its total enrolment, the percentage of enrolment of women in science is 31.4 per cent and in medicine, 30.4 per cent. It is interesting to note that even in the faculty of Engineering/Technology women enrolment as a percentage of total enrolment has consistently gone up from 2.1 per cent in 1975-76 to 6.0 per cent in 1986-87 thereby indicating a healthy trend of more and more women opting for professional courses.

Despite regional variations, going to college is by and large an urban middle-class phenomenon, which is more marked in the case of girls. Interestingly, the proportion of women to men is higher at the postgraduate level than at the undergraduate level. This would suggest that once women in certain areas are able to break through the barriers of prejudice, they proceed to acquire a further degree and perhaps jobs in those areas. The following bar chart reacords some interesting trends in women's higher education : for instance while enrolments in the traditional areas of the Arts and Education continue to expand, so are those in Science, Commerce and Medicine. Medicine acquired respectability as a profession for women by the end of the last century as women doctors were needed for the families of the emergent middle class. The present trend of high capitation in medical colleges might act as a further deterrent.

However qualifications in a particular area do not always mean that women will be in a position to take up jobs of their choice. For example, women trained in medicine generally opt out of private practice which is lucrative in favour of lower salaried fixed hour jobs in public hospitals. It is not improbable that a work situation that involves interacting with male colleagues, dealing with men patients in a variety of situations as well as being on call for night duty may well deter parents or husbands from allowing their fully qualified daughters or wives from taking up employment or setting up practice. Apart from undermining the self confidence of a girl who has invested many years of her life to regorous training in a competitive area, such attitudes result in the under utilisation of scarce skilled resources. The unemployment rate among qualified women in science and technology is almost fifty per cent. Latest figures show that though women's enrolment in engineering has gone up seventeen fold between 1960 and 1983, they are still barely five per cent of total enrolment in that discipline.

CONCLUSION

India presents the paradox of a small women - leadership of sensational ability and a large mass of illiterate and submerged followers. This was so even before 1947, was startlingly true in the year of independence, when we took stock of our inheritance and when speculation was rife about the shape of things to come. It is more than ever so

40 years after independence, and after democratisation has proceeded swiftly. The small dazzling leadership of Indian women remains in politics, education, medicine, public health, law, nursing, administration, journalism, writing, advertising etc. Nevertheless, to generalise from this leadership is to be wholly wrong about the Indian situation. For the great mass of Indian women are still abysmally backward and this indeed, is the main reason why India moves so slowly in the total process of modernising herself.

The world has seen great technological developments and India is taking advantage of the new developments in technology to accelerate the tempo of her industrial and agricultural programmes. The first degree in any branch of Science qualifies a person to work as laboratory assistant or junior technician. A few years ago a degree in any branch of engineering was a guarantee of lucrative job, but times have changed and the profession has reached the point of saturation. Indian women have not patronized the profession of engineering in large numbers but those who have done so have been reasonably successful. Happily in last few years increasing number of girls are enrolling in engineering institutions. New field of computer, electronics engineering is also attracting larger number of women. In the field of science teaching and research the trend is also of great increase.

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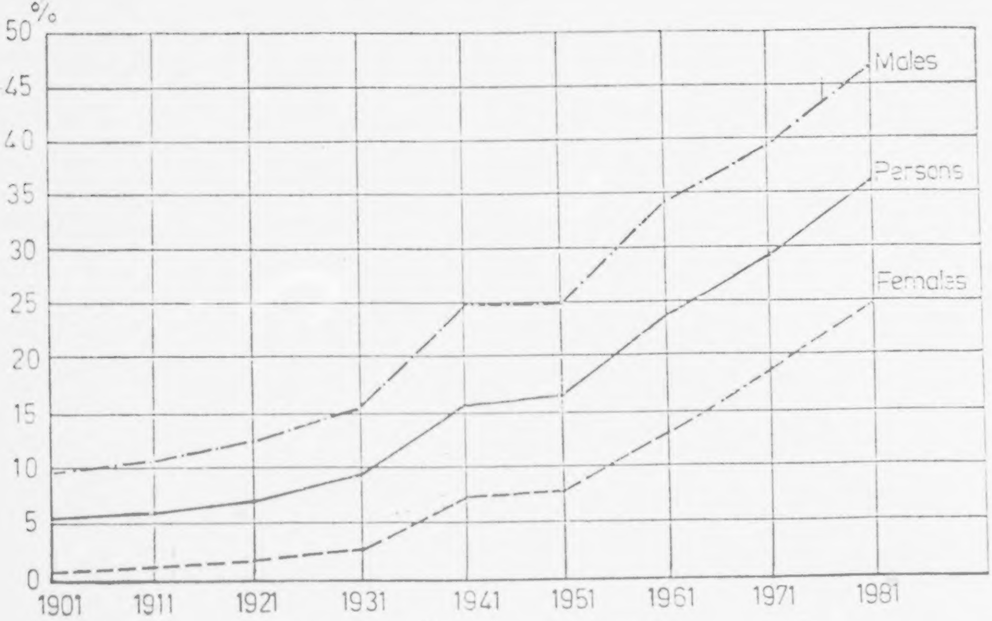
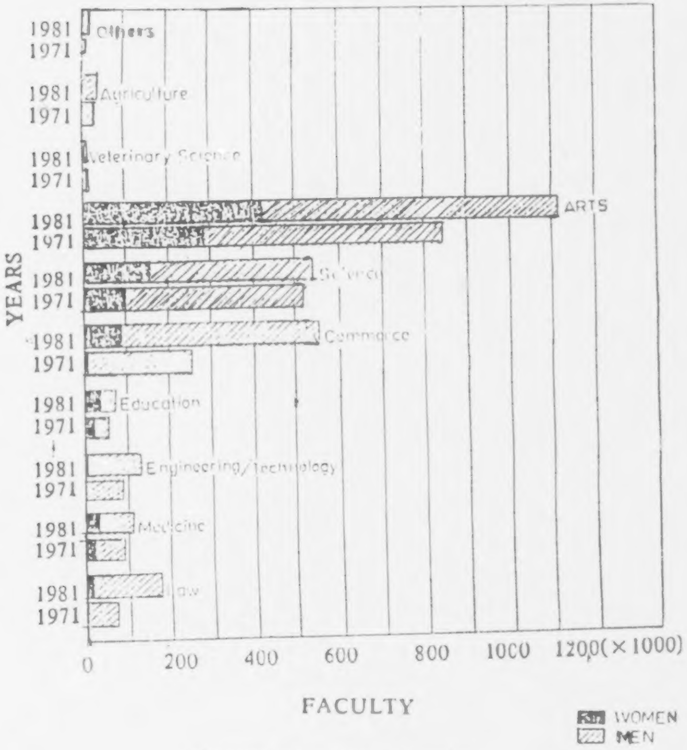


LITERACY PERCENTAGE: 1901-1981

TABLE

DISTRIBUTION OF STUDENT ENROLMENT : SEXWISE AND FACULTYWISE 1975-76 TO 1986-87

Year	Science			Engg/Tech.			Medicine			Agriculture		
	T	W	%	T	W	%	T	W	%	T	W	%
1975-76	463841	111714	24.1	96067	2061	2.1	105140	19208	18.3	30160	432	1.4
1979-80	508763	140098	27.5	118607	4428	3.7	112194	24426	21.8	39962	1181	2.8
1980-81	533859	153868	28.8	128937	4949	3.8	110020	26797	24.4	39231	1311	3.3
1981-82	578766	165666	28.6	130189	5866	4.5	113794	29794	26.2	39318	1390	3.5
1982-83	623545	179650	28.8	142440	7173	5.0	113902	31648	27.8	39425	1595	4.0
1983-84	653092	189685	29.0	153131	8469	5.5	118989	33676	28.3	41588	1719	4.1
1984-85	669563	200632	30.0	159046	10052	6.3	118890	35190	29.6	41741	2045	4.9
1985-86	703467	214581	30.5	164261	9634	5.9	128552	37898	29.5	46422	2011	4.3
1986-87	725328	228099	31.4	169366	10240	6.0	132547	40286	30.4	47864	2138	4.5



Women in Higher Education

The Coalition for Equity in Mathematics, Science and Technology: Organizing for Change

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INTRODUCTION

The Coalition for Equity in Mathematics, Science and Technology (CEMSAT) links researchers and educators from all levels of education, elementary to post-secondary, and brings together activists from rural and urban contexts. The founders of CEMSAT were motivated by the need to move beyond the short-term and localized initiatives which had proliferated throughout Ontario. A symposium was held to review current theory and practices and to make recommendations for future action and strategies for bringing about systemic change.

In this paper, we will evaluate the effectiveness of this organization as a strategy for change in a large and somewhat dispersed geographic area.

HISTORY OF CEMSAT

The founding committee of CEMSAT included representatives of boards of education and post secondary institutions in the area surrounding Toronto, as well as teachers' federations and the provincial government. Positions represented were those with specific responsibility for curriculum support for teachers, teacher education, classroom teaching at all levels (elementary to post-secondary), related community projects and the provision of support for education equity.

In the early meetings of the Coalition, members expressed the belief that there was a need to move beyond local initiatives to systemic structures and solutions. The idea emerged for the creation of a central body which could coordinate resources, avoid overlap of energy and activities, provide support for isolated individuals, and legitimate these activities to administrative structures which do not already give them high priority or budgetary support. An example of a central structure of the kind envisaged and which was considered, was provided by Equals at the Lawrence Hall of Science, Berkeley, California [Kaseberg et al, 1980]. Some members of the Coalition were familiar with this project and supported the idea of bringing such a centre to Toronto, but others were concerned that a model from another country might not meet the needs of Ontario. In order to clarify the provincial situation we decided to conduct a survey across Ontario of current activities and needs.

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[1] The ideas expressed in this paper are those of the authors and do not represent the views of the Ontario Women's Directorate.

SURVEY

A survey was designed and distributed at the annual conferences of the Ontario Association of Mathematics Education, the Science Teachers' Association of Ontario and the Educational Computing Organization of Ontario, as well as at education equity workshops given for in-service education courses by staff of the Ontario Women's Directorate[2].

Through this instrument it was confirmed that most school boards surveyed had a few people who were aware of the need for action on these issues. However, such activities were few and far between [see Robertson, 1988 and Women in Science, Hopefully, 1988] and, since dependent on the interests and energies of committed individuals, were likely to be curtailed once energy dissipated or key people moved on. Seldom were situations documented in which there was top level commitment to the activities. Even though larger metropolitan school boards and universities are more likely to support events, there is still the assumption by the administration of willingness on the part of the organizers to volunteer time. Successful promotion of activities is supported by teachers' provincial organizations, for example through the Women and Math strand of workshops at the Ontario Association of Mathematics Education provincial conference, and the insertion of the issues into Science Teachers' Association of Ontario activities through key executive members.

The collected surveys also indicated a lack of connection among those thinking about and organizing for change. This reflected the experiences of a population which is spread over a large region made up of urban centres, small town communities and rural areas. The knowledge of this reality motivated us to ensure that delegates from outlying areas attended in pairs to assist them in post-symposium organizing. Respondents who were already active or wished to become active in equity issues reported a desire for further information and support. Thus we were convinced of the need for a symposium which would bring together fully committed individuals who were interested in devising coordinated strategies for change.

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[2] The Ontario Women's Directorate is a central government agency which develops policy and provides support for improving the social, legal and economic situation of the women of the province.

THE CEMSAT SYMPOSIUM

Glendon College, York University. May 24 - 26, 1989.

Funding was obtained from the Social Sciences and Humanities Research Council of Canada (SSHRC), under its Women and Work Programme, to hold an event which would facilitate collaboration between researchers and practitioners in order to examine current research related to gender and mathematics; to assess the effectiveness of current Canadian interventions; to explore the directions future research could productively take; and to develop new ideas and plans for coordinating intervention and research in Ontario. The primary purpose was to develop ways to influence the educational choices made by women in Ontario so that they might increase their occupational opportunities.

The size of the symposium was kept small and involved about 70 invited individuals including delegates from a representative sample of boards of education across Ontario. The latter were practicing elementary and secondary teachers or board level personnel who were actively involved in work related to increasing the participation of women in mathematics, science or technology. Other participants included about 15 researchers, teacher educators and subject specialists at the post-secondary level, 3 people involved in teacher support at the provincial level, 4 university career/liaison personnel and 3 representatives from community colleges.

i) Programme

The programme format was designed to engage the participants in future planning of activities and to create a sense of ownership of the outcomes. In order to facilitate discussion and sharing of information the delegates were asked to bring with them a) any resources or materials that their board/institution had developed or used to promote equity in mathematics, science or technological education; b) any available local data concerning female participation or achievement in mathematics, science or technological education; c) information about local intervention initiatives (a display area was provided for this information); and d) a list of questions, suggestions, and concerns that they or their colleagues would like to see addressed at the Symposium.

A variety of influential and interested individuals were invited to the opening evening of the Symposium in order to build public awareness of the Coalition and its aims. The initial sessions of the programme were designed to provide both a theoretical base and information about current activities from which to move forward. The first full day began with a panel discussion which provided a general overview of current research in the areas of girls' achievement in mathematics (Hanna, 1990); participation and achievement in science (Haggerty, 1990); and the effect of teacher attitude and behaviour (Meyer, 1990). A challenging address on feminist pedagogy (Briskin, 1990) began the afternoon. Participants were then divided among six groups with 2 facilitators each for the first of three working sessions.

On the next day, participants attended several workshops on current local level intervention strategies in the following areas: implementation of educational equity across a school board; involvement of parents; comparison of interventions with students; gender and race; subject specific interventions; and resources. The day ended with the second and third sessions of the working groups. These groups developed proposals which were synthesized and presented at the final plenary.

ii) Function of Working Groups

General questions were suggested to the group facilitators to stimulate discussion: What kinds of initiatives, strategies, or actions would you like to see CEMSAT pursue? If a CEMSAT centre were established, what kinds of services would you like to see it provide? What kinds of initiatives, strategies, or actions would you be willing to be involved in?

Each working group session had a specific purpose. The first session was designed to facilitate team building through the sharing of local activities and concerns. The second session was planned to follow all the formal presentations on research and interventions, so that group members were able to identify the gaps in information, research and intervention and to brainstorm strategies to fill the gaps. In the final session the groups prioritized and refined their recommendations and prepared their final summaries. Finally, the working group leaders met with the symposium director and synthesized the individual reports into one list of recommendations.

iii) Recommendations

The working groups recommended that the Coalition undertake the following actions.

Short term actions

1. Distribute regular news releases about Coalition activities to subject associations and key people in the media to reach parents, educators and the business community.
2. Produce and distribute an annotated directory of Symposium participants including initiatives and programmes that they have been involved in.

Long term actions

1. Produce a newsletter which includes resources, upcoming conferences, resource speakers, book and materials reviews, sources of funding.
2. Develop strategies for accessing corporate funding, including for the Candianization of curriculum materials.
3. Plan another symposium.
4. Establish a central, autonomous clearing house for materials and resources for use from elementary to post-secondary.
5. Establish links with subject groups, and federations at the local as well as the provincial level.
6. Encourage the centralization of statistical information.

The working groups suggested lobbying the following bodies on specific issues in order to obtain top-down support for our activities.

Lobbying Bodies

1. Premier's Council on Science and Technology
2. Ministries, boards and colleges of education
3. Ministry of Education.
4. Federal government.
5. Business community.

Lobbying Issues

1. Guidelines to boards on what percentage of their time and resources should be devoted to professional development for teachers.
2. Ministry of Education policy document related to gender equity.

3. Identification of a person in each Ontario school board responsible for gender equity issues.
4. Teacher education to include social implications, ethical constructs and the history of scientific practice.
5. Computers to be integrated into all subject areas with professional development provided for all teachers.
6. Compulsory math and science education through secondary school.
7. Mandatory sex equity component in pre-service teacher education.
8. Peer-coaching on equity issues to be encouraged for all teachers.
9. Catch-up math programmes for adults and teachers, especially elementary teachers.
10. Employment equity for teachers linked to equity for students.
11. Establish links among school, business and community groups.
12. Alternative career information for the 80% of students who are not headed towards university.
13. Ministry of Education support in outlying areas in terms of personnel and resources.

The group members suggested a number of areas for research, but what became clear in the ensuing discussions was that much of the work had already been done but not made generally accessible.

Research

All members of the Coalition engaged in research should be encouraged to popularize the findings of research in the area of education equity in mathematics, science and technology, especially in the following areas.

1. Are there gender differences in student achievement when students are taught through cooperative learning or in other innovative environments?
2. How can the study of math, science and technology be seen by students to be relevant to the work world?
3. Is making the subject relevant to the work world effective in increasing student enrollment and retention?
4. What is the significance of teacher gender to student achievement?
5. Is there any evidence of differential achievement by Francophone students?
6. What are the research findings on the effectiveness of community involvement?
7. What are the implications for female students of streaming?

iv) Evaluation

For delegates from outside Toronto the symposium provided a rare occasion to exchange ideas with others who had similar priorities. The delegates saw their membership in CEMSAT as a useful connection to a network of information and continued support for and validation of their efforts - something they had felt for the first time at the Symposium.

SUBSEQUENT ACTIVITIES

i) Symposium proceedings

The main papers and working group recommendations have been collected and synthesized and will be distributed to all participants and other key individuals and agencies by the end of February 1990. The proceedings will be submitted for publication in book form to the Ontario Institute for Studies in Education (OISE) Press and should be available by the Spring of 1991.

ii) Future Plans

At the follow-up June meeting of the symposium organizing group, the key recommendations were categorized. Strategies for immediate and long-term action were categorized under several headings, for example: lobbying, newsletter, regional networks, setting up a centre. Each heading became a committee which was to take action and report back in the autumn.

iii) Regional organization

Kitchener/Waterloo is a municipality about one hour's drive west of Toronto. Members of CEMSAT from Kitchener/Waterloo have established their own network and have involved many new members who did not attend the symposium.

CONCLUSIONS

The survey and symposium confirmed the need for some sort of provincial organization/centre/communication network which would support and legitimate local initiatives. In a jurisdiction as large and diverse as Ontario, it is clear that central coordination is needed. The educational community has to develop a climate in which those with the power and the funds to provide a central support system become convinced of its necessity. A small step in this direction may be provided by the information contained in the CEMSAT Symposium Proceedings [Rogers, 1990].

The Coalition itself had many positive consequences such as the support the symposium provided to isolated individuals and the stimulus it gave to the formation of the Kitchener/Waterloo network. However, despite the good intentions of the Coalition founders, no further committee meetings have been held since the summer of 1989. This problem of lack of follow-through, while unfortunate, is hardly surprising when such activity is dependent for its continuation on volunteerism and the good-will and individual energy of a small group of highly commited but over-extended people. Until the climate changes, perhaps the most efficient use of energy in places like Ontario with large but widely distributed populations is the forming of support groups of individuals in the same locality who can meet easily and do not require any central coordination or time-consuming structure. Regrettably this leaves the isolated, far-flung people still out in the cold.

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Luleå University 2/1/90
Centre for Women in Research
and Working Life
Ann-Christine Haupt

Visions and Revisions - Women's Studies in Technology

Summary

One of the main objectives of the Centre for Women in Research and Working life is the integration of a perspective based on gender theory into both education and research at Luleå University. This entails active efforts at all levels, from undergraduate studies to research council. It also involves an intensive lobbying activity with contacts both inside and outside the University. There are many obstacles to be overcome on the way, but our relentless efforts are beginning to show good results. We are breaking new ground. When areas of research become defined, we continually start to define new ones.

What is women-oriented research in technology? Is it merely a question of technology or does it possess a wider dimension of social responsibility? In Luleå the work which we have put into integrating a perspective based on gender theory has crystallized into both a postgraduate and an undergraduate course option. In addition we plan to build up an interdisciplinary research environment with foundations in science and technology, and economics.

1.0 Luleå University - a University in the North of Sweden with a Well-developed Research Organization

Luleå University was established in 1971, and today its subject areas comprise technology, business administration and economics, education and music. The University is based in Kiruna, Luleå, Piteå and Skellefteå. Here you can study to become an M.Sc. in a wide range of technological subjects, a Master of Business Administration and Economics, a qualified teacher, church musician or recreation instructor.

Luleå University has a well-developed research organization and a faculty of technology. Examples of the research activity being carried on at the University are environmental engineering, mining and underground construction, mineral processing, industrial management, mechanical and manufacturing engineering, civil engineering, computer technology and electronics. In addition to the research in technology, there are two professorships belonging to the School of Music in Piteå, as well as one professorship in pedagogy.

At Luleå University women constitute at present almost 30% of first-year students of technology, but less than 10% of postgraduate students in that subject area. So far two women have attained the degree of Doctor of Technology, while the number of men who have reached this academic level is seventy-four. There is no woman professor at the University and very few women doctors among the academic staff. The disproportion is obvious. The same is true of all the other universities of technology in Sweden.

1.1 The Centre for Women in Research and Working Life

The Centre for Women in Research and Working Life was established in the year 1982, and its main sources of finance are the National Swedish Board of Universities and Colleges (UHÄ) and Luleå University. The Centre operated as an association, in the form of a project, right up to 1988, when the University Senate decided on 2nd December 1988 to establish a working unit called the Centre for Women in Research and Working Life. The Centre is led by a board and a director. Our activities during recent years have been characterized by a significant expansion, mainly on account of the increased resources we have received through the Swedish Government's regional development package for Norrbotten County - the "Norrbotten Bill". Planning activity in preparation for the coming research bill has also involved an increased commitment on our part with regard to research topics.

1.2 The Objectives of the Centre

The objectives of the Centre for Women in Research and Working Life are to stimulate women-oriented research and research by women at Luleå University, to spread information concerning such research currently in progress both inside and outside the University, as well as to work for the creation of national and international contact networks within the Centre's sphere of activity. In addition the Centre's tasks include research and development, and education.

The Centre for Women in Research and Working Life at Luleå University regards it to be one of its main tasks to work actively for a more even distribution of women and men in research posts at Luleå University. In particular there must be more women taking an active part in research in technology. This is not only (nor mainly), a question of equality of opportunity between women and men, but also a question of labour resources from the point of view of society. The shortage of highly educated engineers is accentuating the situation. The Centre wants to work actively for an increase in the recruitment of women to postgraduate studies in the technology sector.

1.3 Fora or Centres for Women Researchers and Women-oriented Research

About ten years ago fora or centres for women-oriented research and research by women were started in all of the universities of Sweden. In the beginning of their existence these fora or centres were organized on the basis of two questions. One of them concerned the traditional trade union demands by women for equality of opportunity between women and men. The other question concerned the development of knowledge; i.e. knowledge for women and of women-oriented topics. There is an intimate connection between both these questions. Fora or centres for women researchers and women-oriented research play an important role in the achievement of these objectives through the active encouragement and support which they provide for women researchers. At present there are in several faculties all too few women researchers who can function as role models. There is also a great shortage of women tutors on the postgraduate level. There has been a rapid development of knowledge in this interdisciplinary field during the 1980s. The main emphasis has been on the humanities and social sciences. It is our opinion that a corresponding development is needed in technology, as well as in medicine.

2. Strategies

The Swedish Parliament and Government have on different occasions drawn attention to the importance of working for equality of opportunity between women and men in the world of research. In the special budgetary directives issued on 28th July 1988 in connection with the "Research Bill for 1990/93", it was emphasized that the recruitment of new generations of research workers is also a question of increasing the opportunities for women to achieve "fully adequate careers as researchers".

In connection with the "Research Bill for 1990/93" greater efforts were made to give all of Sweden's fora and centres for women researchers and women-oriented research a clearer and stronger profile. The objective of this work is that research from the perspective of gender theory should represent a high-priority area, and as such obtain the necessary basic resources. Most of the planning work in preparation for the coming Government research bill has been carried on on a national level, which means that all of the centres in the country have been working together. We have discussed the coming research bill with the Undersecretaries of State of the Ministry of Education and Ministry of Public Administration, in co-operation with the Commissioner for Sex Equality. We have participated with other centres in planning-conferences where we have drawn up joint strategies. Moreover we have called on the National Swedish Board for Technical Development, the research council in the sector of technology, to elucidate the situation of women researchers with reference to the advent of the 1990s.

3.0 Seminars and Lunch Lectures

During each of the Centre's years of activity different seminar series have been held. Examples are "Women and Medicine", "Women Role Models in Technology and Economics" and "Women and Music", which is in progress during this academic year. A special effort has been put into arranging a seminar series called "Visions and Revisions - New Ideas and Criticism of Old Ideas - on Women, Science and Technology, and Economics". In this context I would like to emphasize the importance of "Women Role Models in Technology and Economics" and "Visions and Revisions".

3.1 Women Role Models in Technology and Economics

The Centre for Women in Research and Working Life had thus far been mainly engaged in the sector of technology, and now considered it important to focus on role models in both technology and economics, and thus prove that it is possible for women to make careers for themselves in both academic research, and trade and industry. The following lectures were included in this series of seminars:-

- Elisabeth Sundin (Ass. Prof. of Economics), Women Entrepreneurs with University Degrees - Is there Something Special about Them?
- Nanny Fröman (Prof. of Theoretical Physics), My Road to Research
- Marianne Nivert (Manager of Swed. Telecom in Gothenburg), How Do Women Hold Their Own in a High-tech Company?
- Berit Ås, The Five Techniques of Domination
- Jan Harding, Gender, Science and Technology - Yesterday, Today and Tomorrow

We feel that the seminar series called "Woman Role Models in Technology and Economics" has been important for the Centre's activity. It is really a seminar series which represents a leitmotif which runs through the whole of the Centre's activity. The series has been held twice, and we are sure to return at regular intervals to this theme. There is a great need for female role models, and the Centre is actively engaged in making the women researchers who are operating in science and technology visible for the young generation of researchers.

3.2 Visions and Revisions

"Visions and Revisions - New Ideas and Criticism of Old Ideas - on Women, Science and Technology, and Economics" is a series of seminars which the Centre organized during 1989. The idea for the seminar series originates from our own realization that we ourselves ought to learn more about technology and economics from the perspective of women. We then invited Sylvia Benckert, Senior Lecturer in Physics, and Else-Marie Staberg, Research Assistant in Pedagogy, from Umeå University to lead a comprehensive series of seminars lasting the whole of an academic year. We met on four occasions each term. The series dealt with the following topics:-

- division of labour according to sex in science and technology
- biological theories and myths about women
- conceptions about what is feminine and what is masculine
- how technology effects women - human reproduction technology, computer technology, and urban and regional planning
- women and economics
- visions - can women influence technology and economics?

A group of about fifteen people followed the whole seminar series. The participants were required to have studied carefully several articles for each seminar. During the course of the seminar series a doctoral course called "Women, Science and Technology" was planned on the basis of "Visions and Revisions".

3.3 Lunch Lectures for Researchers

One of the main objectives of the Centre is to provide support and stimuli for women researchers. One of the means we have of achieving this is to invite all of the women researchers at the University to a lunch lecture each term. Two of the speakers we have invited are Nina

Haglund, Head of the Development Department at ASSI Kraftliner, and Britt-Marie Antti, Project Leader of the Pulp Group of the same Company. They gave an account of their work and projects in progress at ASSI Kraftliner. We also received a visit from the political economist Åsa Löfström, who lectured on her thesis "Discrimination on the Swedish work market : an analysis of wage differences between women and men". As long as women constitute such a small minority of postgraduate students and researchers, there is a great need of networks for women researchers. They often feel isolated and find it difficult to combine the demands of working life and family life. It is the ambition of the Centre to function as a network. These lunches for our women researchers attract a large number of participants and they are of great importance both for the Centre and, most certainly, for the researchers.

4.0 Education

Through active recruitment work Luleå University has a greater number of women students of technology than any other university of technology in Sweden, and can be regarded as a forerunner in this respect. The fact that there are a great number of women students of technology justifies the provision of course options with a female perspective. The Centre regards one of its future tasks to be the development and realization of such courses at both postgraduate and undergraduate levels.

4.1 Women, Science and Technology, a postgraduate course worth 3 study points

The Board of Postgraduate Studies and Research at Luleå University decided on 12th September 1989 to grant the Centre 50,000 Sw. cr. to hold a postgraduate course called "Women, Science and Technology" corresponding to three study points (1 pt.=1 week's full-time study). The course is going to take place during the spring term of 1990 and will be led by Sylvia Benckert and Else-Marie Staberg. They have worked together on several projects concerning women and science. The objective of the course is to teach techniques for analysing and evaluating technology from the point of view of gender theory. The course consists of two main sections:-

1) Women and men and their conditions in the society of today and of yesterday - considered from the perspective of gender theory. In this section the conditions of women in the society of today will be analysed with an emphasis on the relationship between women and technology. Some examples of women who have been active in science and technology will also be presented.

2) Women and technology evaluation. In this section of the course an analysis and evaluation of technologies of great importance for women's lives will be made. The evaluation of the influence of technology on the lives of women and men involves an analysis of how and why technologies develop, how they are used, and the influence which they exert on the environment, social life and culture. The participants of the course will have the opportunity of contemplating

their own area of research, or some aspect of it, from the point of view of gender theory. The results will be presented in a report.

4.2 Science and Technology from a Female Perspective - an undergraduate course corresponding to 4 study points

The Centre for Women in Research and Working Life has put forward a proposal to the Board of Undergraduate Studies in Technology that it should hold a course called "Science and Technology, and Society from the Perspective of Women" - corresponding to four study points (74 hours) - in the spring of 1991. The contents of the course are as follows:-

1) An analysis of the conditions of women in society with an emphasis on science and technology.

2) An historical account of women who have been active in the sphere of science.

3) Studies of the division of labour according to sex and how this has changed under the influence of technology.

4) Some examples of technologies which have a great importance for the lives of women.

A decision will be taken to hold the course in January 1990. The teachers which the Centre intends to engage for the course are, apart from Sylvia Benckert and Else-Marie Staberg, Ewa Gunnarsson, M.Sc. in Work Science and Researcher at the Swedish Centre for Working Life in Stockholm, and Ewa Hedman, Senior Lecturer in Sociology at Umeå University.

5. Research

What is involved in women-oriented research in technology? One example of such research would be the investigation of the role of women in the historical development of science and technology. Another subject area would be the interest and needs of women and men in the technical process involved in urban and regional planning. A third example would be the influence exerted by technical solutions in industrial production on the work situation of women and men. At all of the universities of technology in Sweden the foundation has to be laid for the development of knowledge within women-oriented research in technology. This is of great relevance to equality of opportunity between women and men in research. Women often direct their interests at special subject areas within technology. Chemical engineering and architecture are well-known examples of such subject areas. Environmental control engineering, environmental planning and design, and work environment are also subjects which interest women to a great extent. These are subjects for the future which will certainly continue to recruit many women. Computer technology is a subject which, on the contrary, does not seem to interest women - at least not in its present form at universities of technology. What is the reason for this pattern? It is essential to analyse the use of technology in different contexts to understand the underlying reasons for why so few women choose undergraduate or postgraduate studies in technology. Research on the use of technology is a precondition for bringing about a long-term increase in the percentage of women engaged in research in technology. This is particularly true of subject areas which attract few or no women researchers at present.

Computer technology, which is a branch with excellent prospects for the future, recruits extremely few women undergraduates. In order to create a foundation for the recruitment of women to postgraduate studies, there must be a reasonable proportion of women undergraduates. Research on the reasons why women choose certain study programmes in technology -or rather why they discard others as alternatives - would be extremely important for our possibilities of influencing the future.

It is the intention of the Centre to engage a lecturer or researcher to work at the recruitment of women to postgraduate studies. Our objective is to stimulate in women graduates a greater interest in research studies. The role of the tutor is important and requires acknowledgement. The need of role models is great. The Centre is working actively to make the women researchers who already are operating in science and technology visible for the young generation of researchers.

It is our opinion that in both the technology and economic sectors it is important to work for the creation of role models. It is important to see one's possibilities personified. There are for example in the technology sector few women professors; on the other hand, however, there are many capable women researchers and executives working in industry. One way of enabling these women to become active for longer or shorter periods in the academic life of the University would be to offer them temporary or visiting professorships. It is our experience that, when one starts to search, there are many extremely competent women to be found. They could define and initiate research projects, build up research environments and above all provide good tutoring.

At the Swedish Council for Research in the Humanities and Social Sciences assistant professorships have been established for research on equality between women and men. These special posts have existed for several years and are oriented towards different scientific and scholarly areas. It would be desirable if similar posts could be created, through the National Swedish Board for Technical Development, for example, for women-oriented research in technology. Such posts should be at least assistant professorships. However, to ensure the long-term development of competence and research environments, professorships are the most reasonable alternative.

"HOW THE PRINCESS GOT HALF THE KINGDOM OF TECHNOLOGY."

An exercise: Write your own fairy tale using the above mentioned title. (For men: "How the female part of Man got Half the Kingdom of Technology.")

Hanne Lerstrup Kock
Engineering College of Aarhus, Denmark

One year ago we started planning a seminar for engineer-women. We, that is, Helen Amundsen,Lise Damkjær, Vibeke Fahlén, Hanne Kock, and Anja Springborg, 5 very different women with differing engineering jobs in industry and colleges/universities in Denmark. All of us had experienced the conflict woman/engineer, and none of us wanted to pick sides, one or the other.

"Once upon a time --- ".

These words immediately start off your imagination. The fairy tale idea fascinated us. Nonetheless, we soon decided that writing a fairy tale would be too much for rational, logical engineer-women. Even so, the fairy tale had set the tone.

"**How will the Princess win Half the Kingdom of Technology?**" 1)

The seminar was held 8th-9th of September 1989 at Norsminde gl. Kro, one of the oldest inns in Denmark, 20 km south of Århus. In this idyll from the past we discussed the present and the future. The questions debated by 29 engineer-women and engineer-educators were:

How can we influence technology? and

How can we successfully combine the two roles engineer and woman?

With the following lines I make an attempt to sum up the results of the seminar, to highlight important points, and in between to draw my own conclusions.

Engineer-women of today

First of all, we must admit, we as engineers are part of the current technology system, by virtue of our education and our jobs in trade and industry. Secondly, we have to confess: We find the natural sciences exiting and fascinating. We enjoy solving technical problems. We think technology can improve living conditions for all. But we also know that technology is powerful and must be used sensibly.

Therefore we are puzzled by many people's (especially women's) hostile reactions toward technology. Are we as engineer-women different from "ordinary" women? (This question leads to comparison between natural sciences and the humanities.) Are we as engineer-women different from "ordinary" engineers i.e.men? (This question leads to women's studies.)

Our answer today is: We think we are just O.K. We know now that women successfully can cope with and handle the education and job of an engineer. But we are not so sure, whether we want to continue doing so, given the circumstances of today. We have a vision of a different everyday life. To have this dream come true, we shall need some changes in our society.

Setting the framework. Assessing transformations

Before we start "changing society", we need to put ourselves in a greater entirety. Feminism has given us many clues to the explanation of the development of the western societies. We now realize that a society which supresses one of the principles, the female or the male, will never have a harmonic or balanced development. However, our feminist awareness is not a question of preferring women to men, but a question of listening to the feminine part of all human beings and all conceptions, trying to overcome the current imbalance.

When trying to assess transformations in maledominated areas, I find it convenient to use the six stages outlined by M. Schuster and S. Van Dyne quoted by Sue V. Rosser 2),

"Stages of (Curriculum) Transformation.

1. Abscence of women not noted
2. Search for missing women
3. Women as disadvantaged, subordinate group
4. Women studied on own terms
5. Women as challenge to disciplines
6. Transformed, "balanced" curriculum. "

Each stage gives rise to:

Stage → Questions → Incentives → Means → Outcome

At the seminar we started at stage 5.

Questions at stage 5 are: How valid are current definitions of historical periods, norms for behavior such as technology policies, work- and production organizations, priorities in family life? How do we account for women's experience, diversity, difference?

Questions at stage 6 will be: How can women's and men's experience be understood together? and How do class and race intersect with gender?

The incentive at stage 5 is: Epistemology, i.e. the study or theory of the origin, nature, methods, and limits of knowledge.

The incentive at stage 6 will be: Inclusive vision of human experience based on difference, diversity, not sameness, generalization.

Means at stage 5 are: Testing the paradigms with gender as category of analysis.

Means at stage 6 will be: Transforming the paradigms.

Looking back at the six stages, and considering the questions, incentives, and means of stages 5 and 6, I will concentrate on three areas where changes are needed, namely in

- The culture of engineering
- The culture of organizations and
- The engineering education.

The culture of engineering

The engineering culture in Denmark is historically maledominated and the image of an engineer is still associated with men.

In 1974 4% of the engineers in Denmark were women. In 1986 the figure had risen to 7% and today the percentage among engineering students is 10-20% differing from institute to institute.

Nevertheless, I want to focus on the female and male principles and not so much on the women/men ratios.

> "Women's traditional field is: The private sphere, which expects talents such as feelings, understanding, caring, readiness to help, patience, and a certain modesty and restraint.
>
> Men's field is: The public sphere, which demands rationality, courage, aggressiveness, education, and experience. " 3)

Today, things are changing. Danish women are entering the public sphere. In 1989 60% of women in Denmark have payed jobs outside the home, (parttime or fulltime). Of young mothers with children 0-4 yrs. 73% have jobs.

According to Danish statistics, women are now shifting from parttime jobs to fulltime. At the same time, men are entering the private sphere.

Nowadays 75% men (compared to 90% women) do daily housework. If both husband and wife have fulltime jobs, she still works one hour more daily doing housework than he does.

Will these changes in spheres affect the traditional attitudes of men and women?

The different attitudes of men and women toward nature and technology have often been described by such extremes as dominating/cooperative, exploiting/non-exploiting, rational/emotional.

The German architect Margrit Kennedy 3) has a softer version. She argues that

"the female principles tend to be:
more user-oriented than designer-oriented
more ergonomic than monumental
more functional than formal
more flexible than fixed
more organic orders than abstract systems
more holistic than specialized
more complex than one-dimensional
more socially oriented than profit-oriented
more slowly growing than quickly risen."

In short, we need to think,unthink, and rethink the current values used to assess technology and the attitude to nature.

At the seminar Ellen van Oost 1) described the way in which Arnold Pacey distinguishes three clusters of values: virtuosity values, economical values, and care values.

"Virtuosity values	Economical values	Human needs values
high technology: space travelling, open-heart surgery, nuclear energy, military science	production technology: machine building profit improvements	care technology: cooking, gardening appropriate technology public transport

Virtuosity values have to do with exciting, new, and sometimes dangerous activities, and they are related with high costs and high prestige. Economical values are dominant since the industrialization, and raising profits is an important aim. The human needs values poses the needs for care central. In analyzing the development of technology Pacey finds that the virtuosity and economical values are dominant with activities of men and the human values with activities of women. "

The presentation of these working hypotheses gives all of us - women and men as engineers or users - an opportunity to examine our feelings, sympathies, needs and work theories. Then we may discuss in an open manner, which qualities in technology we practice today and why, and start making priorities for changing the culture of engineering.

The culture of organizations

When a group of people organize, the influence of gender is clear, once you become aware of it. This was pointed out by Anette Wolthers 1), equality advisor at the Danish State Railways.

If you for instance look at the way school children start playing after a lesson, the boys will ask: **What** are we going to play? A game is chosen, a leader starts organizing, everyone can play if you follow the accepted rules. The well-known pyramid has been formed.

The girls on the other hand don't ask what, but **with whom** are we going to play. The game itself isn't important at first, but rather the persons involved. (We will include Joan and Mary, but not Karen.) The incircle girls are more or less equal, and everyone has to agree on a game before it starts. A socalled flat structure has been formed.

These primary behavior patterns can often be recognized among grown-ups too. No wonder organisational communication problems occur, when men and women work together.

Luckily organisation structures are not static and can be changed. This reassuring fact was stated by Anne-Marie Eriksen 1), co-director at the State Information theory Department of Greenland. In her talk she gave examples of different ways of organizing a firm according to the priorities given to personal qualities, such as service- and process consciousness, planning- and working methods, cooperation, continuing education, selfconfidence, openness, and personality.

Projects to initiate change could be:

- to organize collective criticism of priorities in your firm f.ex. pointing out misuse of energy, bad treatment of customers, pollution, inappropriate working hours
- to find out what is missing in your job, what is hindering your creati-

vity
- to tell about your alternative technical ideas
- to continue your education in some way
- to organize a network of engineer-women in similar jobs
- to define your range of responsibility before you start having a bad conscience.

These initiatives, of course, take selfconfidence, but it might help to know that on the job you are judged 20% by your image, 70% by your personality and only 10% by your professional efficiency. 1)

These percentages also show that a break in career because of childbirth should not be regarded as a disadvantage, since handling children only adds to your personality, which accounts for the 70%. (!)

Finally it was pointed out that women in engineering today are treated as **special** and **not** just **strange** as formerly. This gives engineer-women the "right" to set up new standards of their own, and have them respected. This is important, when discussing the practical sides of combining the two roles engineer and woman.

The engineering education

Technology as such is just as much a female as a male subject. This is the way it used to be before engineering started as a profession, and this is the way it should be again. "Polytechnic", a word used for "engineering" in many western languages, means "many skills". Nowadays the skills of an engineer are mainly technical, but it is important to make room for the teaching of non-technical skills as well.

Also the more diffuse notion of attitude needs attention. The teaching of attitudes depends more on the teacher than on the subject. So if we want to upgrade and make visible the feminine values in science and technology, we have to start with the teachers.

Teachers must be given the opportunity to critically reflect upon, analyse, understand, and discuss the concepts of
- equal worthiness, whether it be sex, class, or race. As to gender differences, men must build up their "we"-attitude (sense of collective responsibility), women must strengthen their "I"-attitude (selfrespect and selfconfidence)
- humane technology, that is, a decent and dignified use of technical

knowledge. Technology assesment is of course an integrated part of this concept, used at an early stage of problem solving, in realizing that "prevention is better than cure".
Note: Beware of "the technological fix". The solution to a problem may be not to use technology at all.

The next step is the integration of feminist perspectives into the disciplines, which means transforming the traditional bodies of knowledge and curricula themselves.

Speaking to these issues Charlotte Bunch has cautioned educators not to settle for "add women and stir". Joan Rothschild 4) recapitulates,

> "In so doing, we risk losing and/or diluting the impact of feminist scholarship. To make explicit her culinary metaphor: if one adds a new ingredient to the beef stew without changing the basic recipe, the flavor or consistency might change somewhat, but we still have only a variation of the same beef stew. Or, if one adds a salad to a meal of meat,potatoes, and pie à la mode, one has merely added a course, and not appreciably changed the dietary balance of the menu. In the latter case, the new element can be easily isolated and dispensed with. In both examples, the new ingredient or menu item at best serves as a novelty, a diverting change, but without any lasting impact on the whole. In technology studies,for example, one might add a few women inventors to a history of invention or include a segment on household technology in a course on work and technological change without affecting the approach, structure and format of the course in any meaningful way. .... The aim, therefore, is integration of the new research and transformation of the traditional curriculum. "

and, commenting on her own course, the feminist educator Ruth Schwartz Cowan 4) adds, "We do it .....without saying that we are doing anything feminist .. ..as if it were simply (which it is) part of received wisdom on the subject."

This vision of integration may seem farfetched and seemingly out of reach at many engineering schools, but on the other hand think of what has happened to the public attitude to our environment. It has taken about a quarter of a century to create this attitude, but it has now come to a point, where it cannot be neglected. Engineering students of today (male and female) are openminded and anxious to learn about technology and its impact on nature and society. So let us go on encouraging our male students to discover and cultivate their own female values.

Female values defined as relevant to technical knowledge is the main condition to be fulfilled if the princess is to gain half the kingdom of technology.

Conclusion

A two-day seminar with 29 engineer-women is a stimulating experience. The fruitful discussions proved to me that we as engineers are learning

- to use the language as research instrument
- to explain without facts and figures
- to express feelings, experiences, and values.

This gives us a new means of communication, first, by making our technical background visible, understandable, and relevant to non-technicians, thus encouraging more women to join us.

Secondly, by making the female features in each human being visible and desirable.

"Once upon a time ---".

As in the fairy tales we will go through many a crisis, face numerous trials and development until we reach the happy ending.

It is reassuring to know that in the end the princess **will** get half the kingdom of technology.

A real fairy tale always has a happy ending.

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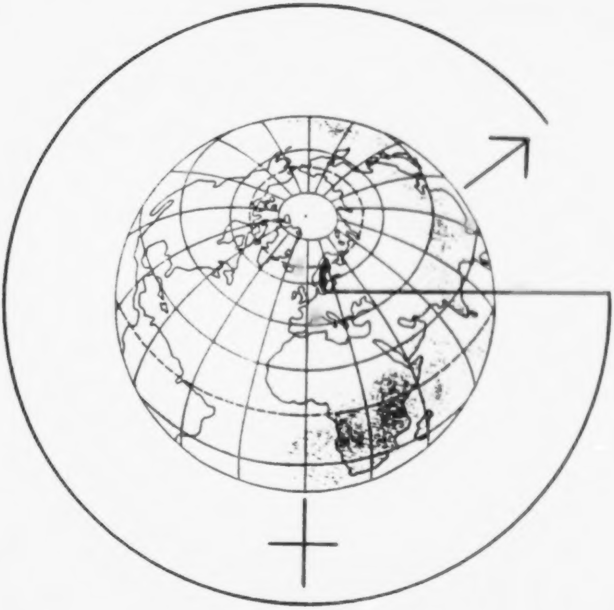

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SUPPLEMENT

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GENDER RELATIONS IN UNIVERSITY SCHOOLS OF TECHNOLOGY*

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INTRODUCTION.

In 1981 the Spanish Census recorded 1.222 women graduates in the field of Engineering and Technology, accouting for only 2,3% of all graduates in this field.

In 1985 there were 7.044 women students enrolled in University Schools of Technology, accouting for 14,1% of all students in these schools, as opposed to a level of 51% for women students in non-technical Faculties.**

The number of women enrolled in University Schools of Technology nevertheless increased by 186,2% between 1975 and 1985.

These figures indicate that, statistically, women have "gained ground". But oneshould also ask if the greater number of women nowadays working andstuding in formely prohibited fields is really a sing of a transformation in gender relations, or if il merely indicates that hierarchical relations have been transferred, the only real change being in their form of expression.

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* The findings presented here are part of research carried out in 1989 on "The academic behaviour patterns and everyday life of women students in higher education", financed by the "Instituto de la Mujer" of the Ministry of Social Affairs, Madrid.

Part of this research was based on in-depth interviews of men and women students in their final year of study at the "Escuela Tecnica Superior de Ingenieros de Telecomunicacion" of the Polytechnic University of Barcelona.
This paper deals only with aspects concerning the students everyday life and gender relations.

** Estadisticas Universitarias 1985, Ministry of Education and Science, Madrid 1987.

CONTEXT OF THE RESEARCH.

With respect to these questions, our working hypotheses for this research were as follows:

a) Given the existence of gender differentiation, the increase in the number of women should alter the behaviour patterns and values that develop in the context of these studies.

b) The increased number of women should also improve mutual understanding between men and women students, depolarizing gender relations and inducing men students to recognize that women's aptitudes are equal to their own.

c) The fact that women students bring new values to these studies should allow them to attain greater security in terms of their new model.

The impact of the presence of women was then considered on three levels: the studies themselves, gender relations, and relations within the group of women. The results obtained were as follows:

1. IMPACT ON STUDIES

Since Electronics is considered on of the "hard disciplines", it is taken up by only a very reduced number of women.

But Electronics is also one of themore selective technical courses of study. This means that there is a highly competitive atmosphere within the school, not only between men students but also between men and women students and indeed between the women. This leads to a pronounced individualism.

Analysis of the official exam results shows that the women students, as a group, obtain the better academic gbrades. This may be seen as the result of several factors:

a) Discrimination against women taking up university technical studies effctively dissuades many of the less daring women from doing so, resulting in a form of selfselection / exclusion (Lavergnas 1986) by which only those who feel very sure oftheir own worth actually choose these studies.

b) The initial admittance criteria favour the entrance women with the better secondary school grades.

c) The challenge to "dare" induces forms of survival behaviour manifested in a greater commitment to studies and thus in a higher success rate. From this point of view, good grades function as a way of protecting oneself in a place that is felt to be alien or a least rather "unfriendly".

However, the academic success of women students is in itself an element of friction in student gender relations. Although "good grades", act as a form of protection in a hostile environment, they also underscore the presence of women and obliges men to accept them as equals. This is why the relative superiority of the women leads to veiled competition between the two groups. The women remain unaware of this competition and are surprised at the negative reactions their success provokes among men.

Men take special note of the grades obtained by their women classmates. They recognize and openly admit that the women obtain better grades, often addign that "they're swots", a discursive strategy obviously designed to explain away evidence of the women's superiority.

Fail grades arefully accepted between men, without any negative reflection on the student's intrinsic interest in his future profession. Failure among women, on the other hand, easily lends itself to comments on their real interests in choosing these studies, giving rise to typical expression like "she's here to catch herself a husband".

This "academic harassment" from men leads women to hide theirsuccesses, thusmaking them appear to be lesser rivals.

Because of female conditioning throughout their education, women students who are beginning these studies know less about technology than do their men counterparts. They thus have less "passion" for high technology. On the other hand, they are much more familiar with subjects having to do with the social aspects of technology. This attitude is reflected in the fact that women tend to take up specialized courses like Communications, wich are more practical in content or have more to do with people than do the more abstract courses like Pure Electronics.

Men Students prefer courses that are more theoretical or more oriented towards advanced research.

However, the courses taken up by women are subject to assessment in terms of the dominant masculine ideology, leading to a downgrading of their academic values to the point where they are considered second-class courses. This in turn supports a positive evaluation of classical masculine behaviour patterns.

With respect to the actual learning process, men students once again fail to recognize women students as their equals.

Many men students ask women students to lend them their notes, saying that the women "have good handwriting". One might expect that, in a technical environment, women would mean appreciating them for what they were actually worth. The symbolic value of "good handwriting" thus acts as a way of covering over the intellectual capacities of women students since, if the value were not referred to, the men would find themselves in a situation of equality with women.

2. IMPACT ON GENDER RELATIONS.

The men students believe that they are disadvantaged by the fact that few women take up these studies, not only because "it makes it hard to find a girlfriend", but because of the social atmosphere created by having a school mostly of men. They say this leads to less comunication, since men always talk about thesame amongst themselves. Others say that the atmosphere would be more relaxed if there were more women students, or that there would be less competitiveness and individualism.

Just as the women's construction of gender frames their relations with the men and impedes their integration as equals in a markedly masculine environment, so the male students' masculine socialization blocks them in the field of personal relations.

The men students seek relations with the women students, since the women are more sociable and "make life more pleasant". Some men say the women "make life more fun", or that they "really help you when you're feeling down". That is, they seek relations with the women on the personal level, in search of their "feminine" values, thus further consolidatin the existing gender relations.

The men students attempt to relegate their relations with the women to an extra-academic sphere and complain when the women students do not behave in accordance with this view. The women, on the other hand, want to be recognized as equals within the school environment and complain about being "persecuted" by the men and about the difficulty of integrating with them to form work groups "really work".

These everyday aspects indicate that even when women students have opted for deviant behaviour patterns on the level of the choice of a career, their incorporation into a masculine model does not bring about a transformation of gender relations. On the contrary, their presence in the school environment is based on confirmation of their gender, thus invalidating their equality.

3. IMPACT ON WOMEN STUDENTS.

The fact that women students form a minority in a markedly masculine environment gives rise to feelings of insecurity and self-blame for academic failure. This mechanism involves a loss of confidence and may even lead to depression, despite the fact that women students, as a collectivity, obtain better grades than their male counterparts.

Women students do not find any security in joining together as a group (which they do spontaneously in the first years of study), since this peer-group relation is a result of their marginalization from the wider environment. In this context, women students form only transitory groups while waiting for the masculine collective to accord them a place.

But such wider acceptance can only come about if the women form relationships with male students and abandon their peer group. The disintegration of the women group is thus hidden behind gender indifferentiation, as expressed in the idea that "what counts in a relationship is the person". Women students give first priority to their relations with men students, believing such relations to be proof of their integration into the university environment. This process impedes women students from affirming their specificity and stops them from expressing any collective desire for their presence to be recognized in terms of equality.

The gender relations in this context develop in terms of the oppositions marginalization / integration and discimination / privilege, thus concealing the mechanisms by wich women students are marginalized. In fact, the women's ascribed feminity brings them certain privileges or advantages from the masculine collectivity.

From infancy, men are taught to "be nice to girls", at least as far as external appearances are concerned. Throughout their lives, men then find that "good manners" bring them greater success with women. Men students thus "take care to treat the girls well" or "with deference": they are "galant"; they believe in "ladies first". These forms of behaviour are well received by women students, whose feminine training has made them expect to be treated like "princesses". In fact, they would be surprised if they were not accorded such deference. This set of behaviour patterns tends to create the illusion that women students are integrated into their environment. But the effect os such behaviour is partly to hide and/or compensate for their marginalization in an adverse context, at the same time as masculine dominance is maintained.

CONCLUSIONS AND RECOMMENDATIONS.

To sum up, the gender relations that develop between women and men students do not allow the women to affirm their "deviant nature", but instead mean that their behaviour is politically and socially recuperated by the masculine norms and values characteristic of studies in engineering and technology.

Taken together, the results of this research show that the quantitative increase in the number of women taking up technical studies leads to no automatic reduction in gender differences, but instead tends to make conflict more acute in a situation characterized by continued maintenance of masculine domination.

The deviant nature of such career choices for women can only be recognized for its own worth and can only give rise to a reformulation of gender if women students themselves develop a collective consciousness of these aspects. In this sens, us as researchers, we have to produce critical analysis of the androcentric values carried by science and technology, as well as a critique of the way University Schools of Technology operate as domains where masculine values still rule.

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WOMEN SCIENTISTS: A VIEW AND A VISION

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Over the past decades, a considerable amount of research has investigated sex differences in ability and performance in natural sciences. The research documented large gender differences in interests and achievement in science. In the USA, for example, the Second International Science Study indicated that boys ranked higher than girls in science at the fifth as well as the ninth school levels (Report on Educational Research, 1984).

These results support earlier findings of the International Education Assessment, which showed that in almost every country, boys outscored girls on measures of cognitive science. Recent science assessment in British Columbia indicated that boys outperformed girls at school levels on questions that assess comprehension of scientific knowledge (Erikson & Erikson, 1984). This assessment revealed small sex differences in Biology scores but increasingly larger increments in chemistry and physics (Kahle, 1984).

Moreover, girls' responses to National Assessment questions concerning interests in science classes and attitudes toward science as a career were consistently negative. In 1977, research reported poorer attitudes of girls toward science, less interest in scientific careers, and less comprehension of science. Unfortunately, this situation had not improved in 1982, when girls reported significant deterioration in their attitudes towards science and their beliefs that science could solve world problems (Hueftle et al., 1983).

In most of the world, there are sex differences in the selection of academic tracks (Science vs. nonscience) as well as in the choice of career. For example, in Jordan, only 37% of the students who selected the science track in 1987 were girls. In Norway, Imsen (1987) reported that only 13% of the girls about age 15 would like to enter a scientific track. A recent finish study (Peltonen, 1987) indicated that only 25% of the girls in the higher level secondary school plan to choose a scientific career.

Indeed, sex differences in high school science and math courses lead to differences in educational opportunities and rewards. According to the data from the University of Jordan Statistical Yearbook (1983), we can observe that while the proportion of men who eventually graduated was only slightly greater than the corresponding proportion of women (55% to 45%), there was much greater sex imbalance in particular disciplines. For example, women constituted only 25% of the students in math, a ratio of 1 to 4. Men were much more likely than women to major in physics and chemistry as well (ratios of about 5 to 1), while women were as likely as men to major in Biology.

Likewise, the National Science Foundation (1984) indicated that, in the United States in 1981, although half of undergraduate students were women represented only 35% of all science degrees. Similar assessments were found in almost every country in the world. For example, Marangu (1987) reported that, in Kenya, ever since the introduction of university education, men have dominated the science and math fields. During the past decade, the enrollment of women in the science fields at Kenyatta University has been on a steady increase. First year women students have increased from 29 in 1977 to 100 1986. This increase is impressive, but when we consider the total of first year enrollments in the 1986/1987 academic year, this is only 28%.

In Poland in 1940, girls represented less than 5% of science students. However, in 1981, girls represented 28% of the students in upper secondary science programs, and 30% of the students in fourth-year college programs (Chivers, 1984).

In Singapore, the number of young women entering the applied science faculties and tertiary institutions is only a fraction of the number of men in the same faculties (Gremli, 1987).

In England, although women constitute over one-third of all students in higher education. They account for less than one in seven undergraduates in physics and for less than one in six in chemistry (Head, 1979).

In Swaizland, a recent need for scientific labor has opened up science education opportunities for women. However, till now, one cannot determine the impact of such programs. Historically, women have been found in practical scientific jobs as in agriculture, family care, education, and health services (Makubu, 1984).

In the year 1982, 25% of all scientists in the USA were women (NSF, 1984). In Jordan, the 1985/1986 Census indicated that only 1% of natural scientists were women. Moreover, none of the scientists who hold administrative, managerial, and planning personnel responsibilities were women. However, many women in science today believe that although women have equal access to scientific training, sustained inequities remain in the work place both industrial and academic.

In 1982, 6% of all USA female scientist and 3% of all Ph.D female scientists were underemployed, whereas 3% of all and 0.07% of Ph.D. male scientists were underemployed (NSF, 1984).

Indeed, these are depressing results, given that most countries in the world have legislation against discrimination in the labour market, and compulsory school programs which aim at promoting greater sex equality.

Some Suggestions for Change

Sex-role stereotyping affects women interested in pursuing educations and careers in science. The stereotype of women as emotional, nurturing, and subjective suggests that women are not suited to science. Moreover, the masculine stereotype, logical, analytical, pragmatic, and objective, which is commonly used to describe science as masculine, may deter women from entering science (Rossiter, 1982), and hence, serves to limit women's potential contribution to science. Sex-role stereotyping, however, is as societal factor affecting both the role and status of women in science. It is anticipated that the presence of female role models is crucial to the success of young women in traditionally male areas and hence, make women feel that success in science is both possible and legitimate.

Strategies for securing a greater proportion of elementary and secondary school girls in science endeavors have to be based on a grasp of feminine culture, a grasp which also trascends merely banal manifestations of that culture like sewing machines and washing (Imsen, 1987).

Feminine culture is characterized by empathy, relationship, and wanting to look one's best. Therefore, we have to focus on the social aspect of science; that scientists must cooperate with each other meet people, and helping them to solve problems. If we try to clarify the uses of science, science will stimulate girls greatly. One way to stress the importance and the usefulness of science is to teach science in the context of a societal problem. This often takes shape as an interdisciplinary project around a theme (e.g., energy problems in developing countries). We can illustrate and explain all kinds of physical, chemical, and mathematical issues in the context of such a theme (Cost & Everts, 1987). Another way of encouraging girls' interests in science is to focus on its relevance to human biology. Kelly et al. (1984) suggested that elementary school science follows the lead of television science in order to find different ways of teaching certain subjects. To illustrate, girls who are uninterested in finding out how machines work, they may be introduced to moments and forces by finding out how muscles work. In this way, we can raise the interests and motivation of girls to science. Also, we have to look for the strengths of feminine culture, and build on those. We should not make science a threat to all what is seen as feminine. We must try to make the cultural implications of gender less oppressive for females.

In addition, since boys report more "thinkering experiences" with certain tools and objects such as cars and screwdrivers, and with certain toys such as electrical kits, it is suggested that elementary curriculum should include such "thinkering experiences" for girls. And that both girls and boys should take technical craft studies in order to increase their scores on spatial-visual measures (Kelly et al., 1984).

When planning to choose a career, young women must have knowledge about science. To increase the number of women working in science, the knowledge of this area must be introduced in a proper way at an early age. It could be suggested that science should be taught in kindergarten, in a concrete way, through describing daily life phenomenon as a part of science and technology. Examples should be taken from the interests of both girls and boys (Peltonen, 1987).

Girls planning a career in science need to be supported. Therefore, teachers should be informed about this fact, and they should be advised how to support the girls. Recent research (Kahle, 1984) reported the following characteristics of teachers who succeed in encouraging girls in science: Are supported in their teachings by parents of their students, maintain organized and well-equipped stimulating classrooms, use non-sexist language in classroom, use information about science-related career opportunities and the prerequisites for them, try to develop spatial-visual skills through exercises and avoid sex-stereotyped views of science as masculine.

Moreover, it is important that women scientists tell the girls about their education and career to provide them with role models, so that they will feel that women scientists are something quite natural and are not very clever geniuses to whom math is obvious. Hence, it is good for them to meet women scientists and see that they are just like anybody else.

At the secondary school, discussion groups for girls could be formed. These groups could be a place where girls could talk about the difficulties they face and they could get the proper information about working life and studies. Girls should be counselled so that the most capable and motivated students are encouraged to pursue science studies at higher levels. Long-term follow up studies on the progress of girls who received help through the counselling program should be attempted (Gremli, 1987).

At the university level, in the USA where equal opportunity programs have had legislative and legal support, rapid increase in numbers of women entering science area occurred between 1972 and 1980. In addition, both the United Kingdom and Sweden have extensive programs to increase the number of women in science. The Swedish program provides for role modeling as well as for course work (Kahle, 1984).

At the professional level, women scientists continue to face threats in their profession. For example, in 1983 more than 60% of mothers in the USA with children under 6 worked outside the home, however, only 40% of all 2-and 4-year US campuses had any kind of child care facility. Moreover, today, it is very hard for young women to get a permanent job as the employers are afraid they will bear a child, and stay at home for almost a year. If it should be compulsory for both men and women to share the parental leave and stay at home with their children, then it would be an equal risk for the employers to employ women and men. This would diminish the discrimination of women having academic degree, and in this way help the women working within the field of science and fostering economic independence as well as maintaining family life (Peltonen, 1987).

Furthermore, inequal pay between men and women scientists persists in most countries of the world. Women scientists earn a fraction of what men scientists earn. A proposed agenda for action, however, should be based on what happened recently in Europe. For example, Swedish women now earn 90% of that of their male counterparts (Kahle, 1984). Indeed, Sweden' supportive family policies have helped more women reach their potential. A more positive vision, however, has come from Arab World where men and women scientists have equal pay.

Finally, science will only raise women's interests, if they live in a fully egalitarian society in which they equally govern, with men, the priorities, ways, and use of its scientific research. Till now, women have little to say in this matter for they are, indeed, underrepresented in science's higher, and more powerful ranks where its future direction is decided. Only women equally govern with men science and society, will there be any hope of science fulfilling the needs of women alike with those of men (Sayers, 1987).

When we have reached such a state, women could perhaps get a good self-confidence in science. Then it might be possible for women to develop an alternative science.

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PRIMARY SCHOOL SCIENCE: A MEANS TO CHANGE SEX-ROLE STEREOTYPING?

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SUMMARY

Science and technology education at the primary level may be a means to reduce sex-differentiated attitudes and values among pupils later on. In order to obtain this goal it is really necessary that children experience and enjoy scientific activities before they are been given sex-differentiated duties. Examples to explain the statements will be given.

Primary science and technology

In many countries, both developing and developed, teaching science and technology is considered important at secondary and tertiary levels of schooling, but not at the first one!

Nevertheless, there are two reasons I see for teaching science and technology to primary school pupils:

1) in order that science and technology contribute, together with all other subjects, to a balanced development of children,

2) in order that the involvment of girls and boys in science and technology education at primary level may help to break down sex-differenciated attitudes and values among pupils later on.

Which kind of science and technology education is appropriate, which approaches should we use? The children, I think should be encouraged to experiment with their hands and then try to explain their ideas about the experiments.

They also must be encouraged to design something in a way that it can be built, then build it, and check that it works properly.

Children are interested to know how a device works and why it works. The techniques the children can use must be very simple, never dangerous, and materials and tools, specially at the beginning, must be well known to children in their environment.

In order to show how the objections 1) and 2) stated above are achieved, the following are presented.

- a brief survey of activities the children have been introduced to,
- examples of the interest the children (girls and boys) were showing during the work, and the kind of discussion that results,
- finally an attempt will be made to explain the statement 2).

Sets of coordinated science activities have been prepared aimed at helping children to develop scientific abilities and at enabling them to grasp concepts like: mass, volume, density, energy, thermal processes, electric current and tension...

The children were trained to compare the thermal, accoustic, optical, electrical, floating, etc... properties of a range of objects made in different materials. The results of these experiments have led them to discuss the properties of the materials and what their structure might be.

Some activities have been specifically concerned with studying the development of quantitative communication skills in young children (not yet able to use the language in written form) through the use of sketches, graphs, symbols and codes. The pupils were trained to represent graphically what they were doing and to devise signs or symbols to show the practical and conceptual operations involved in their work.

Technical problems also played a part; the pupils were trained to build tools and instruments necessary for their work, such as a sensitive balance, thermometer, thermostat, waterclock, raingauge, simple electric switches, simple models of working machines (steam turbin, steam machine, electric motor.)

Simple technology has been used by primary school pupils to build:

- sailing boats made in polystyrene (this work has been the start at grasping the concept of density).
- working machines, (used to indroduce the pupils to concepts such as energy conservation and transportation).
- magnets and simple electric circuits have been used to understand concepts of current, attraction and repulsion and the working of electrical appliances.

The pupils of grade 1 (primary school) who were building simple animal models in cork and small wood sticks (supporting material for reasoning and arithmetical activities) made comments like:

boy: "cork is easily worked"

girl: "it is easy to drive the tooth-pick in the cork, even if I can't do it the first time, I do it again without leaving any bungle"

girl: "cork is light and it makes only a little noice falling down"

boy: "cork is quite like a sponge, it's full of holes, but if it is dipped into the water, it doesnt soak"

boy: "why don't the cork holes allow water to pass through?"

girl: "perhaps there is not one going right through"

boy:	"what is cork used for?"
girl:	"it is used on the table to put the hot saucepan on"
girl:	"round pieces of cork are used as stoppers for bottles"
boy:	"cork is also used to cover the walls of a room like a cinema"
boy:	"what is cork made of?"

The results of all the activities described show that the children have really understood the sense of the work they have done. For example, during the activities dealing with an approach to the concept of density, the children realized that an empty aluminium box could float because it was not a block, it was an object made in aluminium and air.

Through science and technology, the child may achieve the willingness to look for a reasoned and gratifying interaction with the world. It creates a sense of competence and a feeling that even if he or she cannot do something today, maybe it will be possible tomorrow. Clearly, within such activities a considerable space has been given to discussion about physical principles underlying the experimental work and to plan further activities.

In order to be effective for children, scientific education must be developed gradually; the pupils must be given opportunities to observe, to try and to discuss. They also need time for thinking things over before they feel sure enough to make a suggestion.

Science and technology education at secondary level are generally presented in a way that the only thing the pupils can attempt to do is to learn the most important ideas and laws. But the students who have not had the experiences on which the theories are based, should be able to make good these gaps but it takes a lot of time to do. The only students who really understand scientific topics are those who are already interested and who can also devote themselves to study. The others whose interest has not been aroused, or who have been given other duties or responsibilities, take little interest in science. In particular the girls are left out the game: it is well-known in Italy, for example, that they get more involved in family business than the boys. In order really to give girls and boys the same opportunity to take an interest in science, it is necessary that all the children experience and enjoy scientific activities before they are given sex-differentiated duties. The right moment, I think, is precisely at primary school when the science activities may be interesting and amusing games.

I will conclude my paper by quoting: "We conclude that women turn away from science as a vocation or profession, for reason that have little or nothing to do with their intellectual ability. If women are to become more successful, it will be because they are more involved and experienced, and because social expectation toward their role in society has changed ..." (Piburn, Baker).

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Paper to the European and third World GASAT Conference

"COMPUTERS AND COFFEE"

The Design of Womens' Open Computershops

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"We want the women to feel safe and later on daring with the computers. Right from the start we say to the women that the only thing they aren't alllowed to do when they work with the computer is to pour coffe into the keyboard."
(Kirsten Kristensen, leader of Århus' Open Computershop for Women.)

In this paper I describe the womens' open computershops concerning their structure, contents, attitudes and values. This presentation is outlining the pedagogy for women developed and applied in the computer shops, a feminist pedagogy.

INTRODUCTION

The open computer shops for women started in Denmark in 1984 as job- creating initiatives for unemployed women. The shops with staff from 3 to 7 people consist basically of 2-3 rooms with 6-10 personal computers, printers and other hardware, walk-in free offer for women, short-term computing courses in a broad range of programmes, offers of guiding, counselling and establishing of self-steering jobhunting-groups of users.

An overall aim for the shops is to strengthen selfconfidence in the women using the shops. The users are mostly in a stage of transition in their lives, moving from a state of perhaps rather passive unemployment towards new possibilities and challenges, to confront and try to cross own borders.

In 1990 I completed an evaluation on behalf of The State Labourmarket Board of most of the existing open computershops.

I evaluated 8 open computershops for women. 1

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[1] Munck, Agnete: Åbne datastuer *Evaluering af åben datastuer for kvinder*, Arbejdsmarkedsstyrelsen 1990, 120 s., udk. sommeren 1990

A feminist approach in teaching women computing

Although all the projects I have studied in the evaluation are defined as projects directed towards women, they do not all perceive themselves as feminist projects.

I shall here concentrate on what I define as *feminist* approach in computershops for women. I will therefore focus on two computershops in Denmark: "Åben datastue", Århus and "Åben datastue for kvinder," Odense. These two computershops for women represent several years of experience in developing, applying and evaluating feminist pedagogy.[2]

Results from the feminist computershops

The computer shops for women have generally been able to attract women from the target group and to computer-train, counsel and encourage users further on to either job, short-term job-training courses or further education. It seems as though this jobcreating initative is a useful way to guide unemployed women out of their situation and into new directions with either jobs or further courses.

ELEMENTS IN THE FEMINIST APPROACH

The presentation falls in three categories, namlely structure, contents and the attitudes and values underlying the womens' computer shops.

Structure

The computer shops are formally relatively independent from but cooperating with local financing and other authorities.

Within the overall target group of women without jobs the feminist computershops put the assumed and perceived interests of especially the adult, unskilled and often "computer-frightened" women as basis of the shops' design.

The computer shops for woman have an all-female staff of whom the majority have education in the humanities.

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[2] Inspiration har also come through interviews in Esbjerg Åben Datastue, "EDB for Dig" in Aalborg and "Åben datastue ved Kvindedaghøjskolen i Næstvedområdet", three other feminist computershops .

The fysical design of the computershops is pleasant. Paintings on the walls, green plants and a table with available tea and coffe make the fysical environment inviting. The computers are arranged along the walls so that users and instructors can communicate unhindered. Each user works with a computer of her own.
Participants have a nice coffeebreak-room for smoking and talking.

Originally the aim of the shops' walk-in free offer was to recruit course participants. Although there is a decreasing rate of new users in the shops, the computer shops for women maintain their walk-in-offer. They do this in order to attract those women who are skeptical about computers and who are in a phase prior to a decision on a course. Also, the open environment is important part of the well-being of staff and users.

Teaching schedule in computing courses are designed to meet demands of users who have schooling experiences that are not fresh. Daily teaching time is mostly not more than 4 hours which for many adult women is satisfying. Courses range from 30 to 50 hours in all.

Contents

The equipment in the computershop is well functioning and breakdown in hardware is repared quickly. Software range over a broad variety. Programmes are professional with relevance for the labour-market combined with high degree of appeal to non-experts. Softwaresupply is often evaluated and extended. WordProcessing, SpreadSheet, ComputerAidedDesign, lay-out-, drawing- and Desk TopPublishing programmes are amongst the most common programmes. Programmes relevant for industry is also taught, e. g. programmes training Computer Numerical Control of machines. Most manuals are translated and re-written by shop staff with examples familiar to women. For example the SpreadSheet in Odense computershop is designed to compute pricevariations in the dishes of a restaurant when different raw materials are combined in the menu.

Courses are designed in detail and courseplan presented to the participants at coursestart. After completing courses, participants and teachers together evaluate the courses, and coming courses are being adjusted on basis of the evaluations.

Content of courses is very varied. Computertheory and computer-training mix with excursions and discussions of new technologies and their impact on society and the individual lives. A broad range of technologies is treated: E.g. In Vitro Fertilization and motherhood, history of the sewing machine, discussion of the concept of technology as masculine.

Computertraining itself is based on theory in class an individual work at the machines. Courseparticipants each work step by step in their own tempo on the basis of self-instruction with the help of manuals combined with guidance from instructors.

Attitude and values in the open computershops for women

The descriptions above can give impressions of the ways the open computershops for women teach women computing.
But these descriptions are not sufficient in comprehending the processes in the open computer shops for women.

Imbedded in the formal structure and the tangible contents of the open computershops for women is a set of attitudes and values.
These attitudes an values emerge through numerous ways in all levels in the computer shops.
One fundamental attitude strikes the delicate balance between the open-armed acceptance of the women, and the clarity of expectations to them from the staff.

"Safety in challenge"

Although the computershops' attitude represent a firm confidence in womens' ability in learning computing, s it's accepted that users in the

shops often are very nervous and inhibited, that they have a pictures of themselves as absolutely impossible at the computer and that they have exaggerated opinions about computers´ potentials, some times amounting to "fear of the computer".
This fear many women feel do to some extent reflect existing negative images of women and their relation to technology. These existing negative pictures have turned into negative self-images towards their own ability to cope with computers.

Computershop-staff is expecting each courseparticipant not only to formulate but also to elaborate own anxieties, fear of failures and negative self-expectation. To that end the computershops for women formulate and confront the women with alternative interpretations of themselves both generally and specifically in relation to computing.

The alternative pictures the computer shops offer represent an urge to change attitude and self-images, to reject self-putdowns, to accept that learning without failure doesn´t exist. The women are encouraged to let themselves be a bit less respectful with computers, more playful and daring.

One overall pedagogical tasks is to transmit the shops´ confidence in the women on to the women themselves

This transmission of confidence happens, as I see it, when the women feel safe enough to accept seemingly risky challenges.

Conclusion

The feminist pedagogy used in the two computershops I here describe emerges in all levels of the computer shops.
It emerges in the logogram showing women, in the homelike computer-room, the green plants and the coffee, in the room very litteraly given to users of the shops. These rooms are the users´, and women here, on their own ground so to speak, work in self-organized

job-hunting or studygroups. A lot of constructive contacts between the women are made in this way.

Examples from womens' world of experiences are constantly drawn into curriculum, and womens' often negative self-images are opposed. The participants are taught new computing skills and develop qualifications that are crucial for their ability to take jobs and obtain economic independence.
But the participants are also seen as societal subjects that have opinions concerning the technological development, and these opinions are debated within the frame of the shops' courses.

The leaders and staff in the computershops for women are role models for the women in the courses. Most of staff have backgrounds in the humanities, not in technics or in computing, and they know from themselves the difficulties in starting to learn computing. Also, staff at times reach their own professional borders and it thereby becomes visible that crossing borders and learning is a constant challenge.

The pedagogy in the womens' computer shops has feminist roots because:

- it opposes concepts of womens' subordination to men

- it seeks to make womens' ways and values both visible and useful in the work of the computershops

- it creates a room where the female is the norm, not the exception.

The fundamental values underlying these attitudes are appreciation of women, respect and equality.

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CONSTRUCTING GENDER - FAIR SCIENCE ACTIVITIES AND ASSESSMENTS

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Abstract

The paper includes a review of the findings of the U K APU Science project on gender differences in science performance. The Science project has carried out research and surveys of populations of 11, 13 and 15-year old pupils in England, Wales and Northern Ireland from 1978 - 1989. The research findings show the various ways that pupils' different experiences, self-images and expectations affect their engagement with, and achievement in science. Direct links between girls' and boys' different out-of-school experiences and gender differences in scientific achievement are identified. The more indirect effects of girls' and boys' alienation from particular contents, contexts and ways of working in Science are also spelt out in the discussion of the research findings.

The review emphasises the significance of the relationship between pupils' affective and cognitive behaviours in determining gender differences in science. Evidence from the review was used to analyse pupils' performance in order to isolate those aspects of activities which either lower or raise, girls' and boys' performance.

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CONSTRUCTING GENDER - FAIR SCIENCE ACTIVITIES AND ASSESSMENTS.

INTRODUCTION

Research into the differences in attitudes, experiences and achievements of girls and boys as they relate to science has significantly changed direction. In the first half of the 1980's research into gender established girls' alienation from, and under achievement in, science. The focus of much of this research was on documenting the nature of gender differences rather than establishing their sources. Subsequent attempts to redefine the science curriculum to combat gender differences reflected this focus and achieved little success. This lack of success led to a shift in research emphasis from the effects of gender differences to the processes which lead to their creation. This shift highlighted the significance of the way science is taught and led to a critical review of the learning experiences pupils receive in schools.

To combat girls' underachievement in science it was previously thought necessary to define a science specifically for girls. The perceived need now is for a pedagogy that makes the domain of science accessible to all. By accessible I mean that pupils can both acquire scientific knowledge and challenge its basis and use. Consequently, there is a world-wide concern to identify the characteristics of gender-inclusive science education which fosters a creative, critical, problem-solving approach to science. This will enable all pupils to develop the concepts to understand causes and effects, predict the consequences of acts and generate and evaluate explanations of phenomena.

The paper reviews the work of the United Kingdom's Assessment of Performance Unit Science project (which includes surveys of populations of 11, 13 and 15-year old pupils and associated in-depth research studies) and relates it to other international research findings to establish some of the critical features of gender-inclusive practices.

BACKGROUND

Table 1 shows the survey results for the UK Assessment of Performance Unit (APU). The five annual science surveys were conducted between 1980 - 1984 and included:

three practical tests - measuring skills, observation skills and practical investigations; tests of science content; and other process skill measures (Murphy and Gott 1984). The suffix indicates the age at which the gender difference occurs.

TABLE 1 - A REVIEW OF ADU FINDINGS ON GENDER

APU tests	Results	Type of Test
Use of graphs tables and charts	$B_{15}>G_{15}$	Written
Use of apparatus and measuring instruments	$B_{15}>G_{15}$	Practical
Observation:	$G>B$	Practical
Interpretation	$B_{13,15}>G_{13,15}$	Written
Application of: Biology concepts	$B=G$	Written
Physics concepts	$B>G$	Written
Chemistry concepts	$B_{15}>G_{15}$	Written
Planning Investigations	$B=G$	Written
Performing Investigations	$B=G$	Individual Practical

The pattern of gender differences for other national and international surveys of science content has consistently shown the largest differences for physics, with chemistry intermediary and biology either showing no difference or a small difference in favour of boys (see for example Kelly 1981, Johnson and Murphy 1986). The APU results reflect this pattern and provide a broader picture of pupil's performance in science.

Table 1 shows that gender differences, in favour of boys, appear to increase as pupils go through school. However, from age 13/14 the curriculum experiences of pupils in the UK vary considerably. When pupils with the same curriculum backgrounds are compared all performance gaps at age 15, except for those for applying physics concepts and the practical test - making and interpreting observations, disappear (DES 1988). In the APU surveys the gap in physics achievement between girls and boys increases with age.

The evidence from APU research since the surveys and from studies in other countries shows that whilst girls are well able to handle a wide range of science activities their learning in physics remains an international problem (see Humrich 1987, Tamir 1989 for example). It is also the case that, inspite of their scientific competence many girls' continue to dissociate science from their future careers and lives - unlike boys.

Studies such as Humrich's (1987) Which compared the results of the second international science study (SISS) for Japan and the USA show that the educational objectives of a culture can influence girls' achievements and attitudes to science. However, the cross-cultural uniformity of many gender differences in science indicates that the 'masculine' image of the subject remains a problem which continues to affect girls' engagement. Recent research in Thailand provides support for both of these hypothesised sources of gender differences (Harding, Hildebrand and Klainin, 1988). This research showed that girls at age 16 - 18 performed at least as well as boys in physics and better than boys in chemistry. In practical laboratory tests girls out-performed boys in both physics and chemistry. Several reasons are offered for these uncharacteristic results. For example science in Thailand is compulsory; the teaching approach is practical; chemical tasks have a 'feminine' image as do some of the physics tasks; there are no differential expectations of pupils and females participate in all levels and fields of employment.

The Thai research reaffirms the widely held view that girls' achievement in physics and their image of science can be altered if the cultural expectations of girls and boys, and how these are reflected in the organisation and values underpinning the school curriculum, are reconsidered. The problem for countries like the UK is to identify gender-inclusive practices which aim to promote equality both within and outside of school, and which at the same time take into account existing inequalities. To tackle this problem we need to be aware of the interaction between children's learning outside of school and inside.

The APU surveys, along with others (e.g. NAEP 1979), have shown a polarisation in pupils' out-of-school experienceS in their chosen hobbies, pastimes, choice of reading and television, and views of careers (see Johnson and Murphy 1986, Murphy and Qualter 1986, for a discussion). These differences indicate some of the ways in which perceptions of gender appropriate behaviours are constructed. Such perceptions alter how girls and boys engage with school science and their subsequent achievements in it. The discussion focuses now on the relationship between girls' and boys' out of school experiences and their performance in school.

FACTORS TO CONSIDER IN DEVELOPING GENDER-INCLUSIVE PRACTICE

Differences in Experience

Kelly (1987) found little relationship between previous science-related experience, subject choice and achievement. The APU results paint a different picture. For example, on tests of use of apparatus and measuring instruments (see Table 1) boys' performance is better than girls' on precisely those instruments that they claim to have more experience of outside of school. The different experiences of pupils does not just effect the skills they develop but also their understanding of the situations and problems where their skills can be used appropriately. Gender-inclusive practice needs to focus on both the nature of the differential experiences as well as their consequences. For example, boys at age 13 and 15 in the APU surveys were better able to use ammeters and voltmeters yet they do not have more experience of these outside of school. They do, however, play more with electrical toys and gadgets than girls. Such play allows boys to develop a 'feel' for the effects of electricity and how it can be controlled and manipulated. This is an essential prerequisite for understanding how to measure it. Gender inclusive classroom strategies would have to provide girls and boys with problems whose solutions, as they perceive them, require certain measurements to be taken. In this way pupils will select instruments themselves, engage with them purposefully and so become competent in the use of them.

Another example of the influence of different pastimes relates to girls' well documented lack of experience of tinkering and modelling activities. A common strategy to overcome this is to provide young children with modelling resources, such as Lego, to play with. Teachers are often discouraged by girls' apparent failure to engage with these resources. When boys play with Lego they do so in a purposeful way. Their play allows them to establish the link between their purposes and the potential of Lego to match them. A gender-inclusive practice would have to allow girls opportunities to explore this relationship by providing problems that they find motivating where modelling can serve a useful function. The same holds true for other areas of pupils' inexperience. Erickson and Farkas (1987) investigated gender differences in 17-year old students' responses to science tasks. They found that females only drew on their school experience whereas males were able to draw on a combination of formal experience linked to their everyday 'common sense' knowledge. This gave the males an advantage in generating scientific explanations. From an assessment perspective it is important to collect information about pupils' experiences out of school so that the effects of differential experiences do not become interpreted as innate differences between pupils.

Girls' lack of certain experience means that they approach some learning situations with diffidence and fear. This has been noted in girls' response to practical work (Randall 1987). Talking to pupils in the APU research studies, as they carried out science investigations showed that more girls than boys reject investigations where they are expected to use overtly scientific equipment. If the identical investigation is set in an everyday context and such scientific equipment as measuring cylinders and beakers is replaced by measuring jugs and plastic cups girls feel competent to tackle it (DES 1989). However, such a strategy has its drawbacks. Faced with an apparently everyday problem both girls and boys seek everyday solutions. Consequently they tend not to control variables or to collect quantified data. A gender-inclusive approach would, therefore, have to start by working in everyday contexts to enhance the confidence of these pupils but only using problems that can be solved using some degree of rigour. Rigour that is obvious to the pupils hence there is a need, understood by the pupil, for scientific equipment.

Differences in ways of experiencing

The scale of the APU surveys made it possible to discern a pattern in questions where gender differences arose. It showed that, irrespective of what scientific criterion an activity focuses on, or what age the children tested, questions which involve such content as health, reproduction, nutrition and domestic situations are generally answered by more girls than boys. The girls also tend to perform at a higher level on these questions. In situations with a more overtly 'masculine' content e.g. building sites, racing tracks, or anything electrical, the converse is true. For example girls and boys are competent at using graphing skills but if the graph is about traffic flow through a town boys achieve a higher score than girls. Whereas for a graph about the day in the life of a secretary the reverse obtains.

Children come to school with learning styles already developed and with an understanding of what is and is not appropriate for them (Cohen 1986). The source of children's different world views can be found in the different patterns of nurturing that many girls and boys receive (Chodorov 1978). Alienation from areas of experience demonstrated by the pupils' reactions to task content is a major problem for pupils' learning in science. What children judge to be appropriate they tackle with confidence, what they consider alien they tend to avoid. This avoidance leads to underachievement because girls and boys fail to engage with certain learning opportunities. It is important that teachers identify and tackle the effects of alienation. This would mean initiating pupils' science learning in themes which overlap each pupil's personal area of experience. Once pupils' experiences are validated they can be encouraged to share their various outlooks on the world. In this way the teacher can help them to broaden their view of the relevance and applicability of their knowledge. The problem for assessment is more complex. In assessments, questions which fail to measure the criterion aimed for are sources of invalidity which need to be eradicated for the summative purposes of reporting and evaluating. On the other hand, for formative assessment to aid curriculum planning such tasks are invaluable.

Characteristic of Pupil-friendly Tasks

Rennie (1987) reporting on a study of 13-year olds in Western Australia found that the relative inexperience of girls can be overcome in an activity-orientated style of science teaching. Similarly the science curriculum of Thailand which appears to support girls' learning is described as activity-based, learner-centred, and focuses on novel aspects of inquiry and discovery. The APU observation tasks, which girls across the ages achieve higher scores on than boys, are also novel and the majority are activity based. These tasks showed few of the content effects described earlier as pupils perceived them in terms of the observations required or the action to be observed rather than the content. Girls' performance was highest on the tasks that allowed them to formulate their own hypotheses and to test them out before reaching a conclusion. These were also the tasks that girls and boys preferred. The combination of an active response and an open approach made these tasks accessible to the girls as their view of relevance prevails.

A closer analysis of pupils' responses revealed that girls and boys observed different features of phenomena. Boys more often focus on mechanical and structural details which reflects their greater involvement with modelling and handling mechanical gadgets in and outside school. Girls, on the other hand, attend to colours, textures, sounds and smells, data boys typically ignore. Observation tasks about chromatographic effects, for example, assume that such variables as colour are obvious. However, boys tendency to disregard colours means that tasks of this kind make little sense to them. Hence boys tend not to respond and as a group achieve lower scores. In tasks which specifically ask pupils to take note of variables such as sounds and colours etc. it is clear that boys are well able to do so. The problem arises when the task is left open for the pupils to impose their understanding of relevance. If teachers encourage pupils to reflect on and compare the meaning and outcomes they derive across a range of focussed and open tasks then they will become aware of a broader range of issues in science.

For girls the effects of attending to different sensory input are less obvious. The tasks that focussed on mechanical and structural variables were also open and active. The girls are, therefore, able to respond to them but the tasks they actually face are more difficult than intended. This arises because girls have to first eliminate the variables which they consider relevant before being in a position to appreciate the significance of structural or mechanical details. This renders them less efficient and in assessment situations has been found to lower their performance levels. To discern these effects it is necessary to identify the strategies that girls use to tackle tasks. This would mean encouraging them to talk through what they are doing with each other and then with the teacher. This is necessary to help girls focus on the variables they might otherwise have difficulty with. For assessors it is essential to interpret pupils' responses in the context of the task they perceive if the results are to inform curriculum planning. The importance of considering girls' strategies is further reinforced when we look at the way they formulate problems in science.

Differences in Problem Perception

One of the in-depth studies into gender carried out in the APU research looked at the type of problems girls and boys perceive when faced with the same situations. The study looked at pupils in both primary and secondary schools. The study showed that typically girls tend to value the circumstances that activities are presented in and consider they give meaning to the task. They do not abstract issues from their context. Boys as a group conversely do consider the issues in isolation and judge the content and the context to be irrelevant. An example of this effect occurred when pupils designed model boats to go round the world and were investigating how much load they would support. Some of the girls were observed collecting watering cans, spoons, and hairdryers. The teacher assumed that they had not 'understood' the problem. However, as the girls explained, if you are going around the world you need to consider the boat's stability in monsoons, whirlpools and gales - conditions they attempted to recreate. There are many other examples of these effects (see Murphy 1990 for example).

These examples of girls' solutions are often judged as failures either because their problems are not recognised or because they are not valued. Such responses to girls' perceptions of problems means that they do not receive feedback about their actions or if they do it requires them to deny the validity of their own experiences. In assessment situations their responses, which reflect good scientific understanding, are all too readily labelled as error responses. Again, as in the observation tasks, the multi-variable nature of 'girls' problems' makes them more difficult than intended.

Other instances of pupils' different perceptions of problems reflect the way girls are encouraged, outside of school, to be concerned with everyday human needs. The boats the pupils designed in the task mentioned earlier demonstrate this. The designs covered a wide range but there were striking differences between boys and girls. The majority of the boats of primary and lower secondary boys were power boats or battleships. The detail included varied but generally there was elaborate weaponry and next to no living facilities. Other features included detailed mechanisms for movement, navigation and waste disposal. The girls' boats were generally cruisers with a total absence of weaponry and a great deal of detail about living quarters and requirements, including food supplies and cleaning materials (notably absent from the boys' designs). Very few of the girls' designs included any mechanistic detail. Similar findings were obtained for other design tasks.

The combination of girls' contextualised response to activities and concern for human needs has several effects. For example, in the boat task when the pupils had to focus on an aspect of their design i.e. the shape of the boats to investigate it further the boys had few difficulties. The girls however retained their initial design details, hence the shape of the boat had to serve several functions and was not 'isolated' variable. This approach often made it difficult for girls to pursue the teachers' focussed investigation. Girls retain these design details because they are an important aspect of the problem they formulate. To enable girls to focus on a particular aspect teachers would need to relate the focus to the larger problem and thus demonstrate the point of it. Unfortunately all too often it is the larger problem which is considered pointless and is usually only introduced to establish a superficial link between school science and everyday life. Such an approach disadvantages girls particularly when teachers and assessors fail to recognise their own assumptions i.e. that the content and context in which tasks are presented are trivial

It is for similar reasons that girls have difficulty with some multiple choice items. Girls in taking account of features that the assessor regards as 'noise' see ambiguity in the responses offered and commonly either do not respond as no answer 'fits' or give more than one response. The high value placed on decontextualised knowledge in the curriculum means that the responses girls' tend to give which are qualified by the circumstances in which they present them are often dismissed as 'lacking in clarity'.

DISCUSSION

The data from the APU research demonstrates some of the ways the science curriculum continues to fail to provide access to girls. The lack of access arises not because girls are scientifically incompetent but because there remains a lack of awareness that the values that underlie the curriculum are biased; and that differential cultural expectations of pupils alter their learning outside of school and, hence, in school. The discussion has highlighted several ways to make the curriculum more accessible which in turn challenge the values that it represents. Whilst cultural expectations remain unequal it is essential for teachers to establish girls' and boys' different images of the world and their place in it. If this becomes the starting point for science learning then any subsequent focus on specific aspects of scientific knowledge can be negotiated with, rather than imposed on, pupils. In this way alienation is avoided and pupils have the opportunity to share and come to understand alternative perspectives.

Open tasks that allow all pupils' views of relevance to prevail are to be recommended. However, it is important to establish what task the pupils actually perceive in these circumstances. The pupils' tasks, particularly the girls', may require them to develop complex strategies in their attempts to bridge the gap between their world views and assumed notions of scientific relevance. Problems set in a social context of human need provide opportunities for girls to see the links between their views of relevance and the purposes that can be appropriately addressed by science. Such opportunities are necessary for girls to make sense of tasks and to enable them to integrate their developing scientific awareness with their existing knowledge.

From both a teaching and an assessment position there are two fundamental messages that emerge from the APU research. First that it is essential to find out what task the pupils perceive rather than assume that they interpret activities in the same way. Second that account had to be taken of the strategies pupils use as well as the outcomes they achieve. The need for teachers to consider the different experiences, self-images, and expectations of pupils is even more critical now that science is part of the compulsory core curriculum for children of 5 years to 16 years of age in the UK.

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